

1875

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REPORT

TO THE

LOCAL GOVERNMENT BOARD

ON THE

RECENT EPIDEMIC OF SMALLPOX IN THE
UNITED KINGDOM

IN ITS RELATION TO

Vaccination and the Vaccination Laws,

BY

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REPORT TO THE LOCAL GOVERNMENT BOARD BY
DR. SEATON ON THE RECENT EPIDEMIC
OF SMALLPOX IN THE UNITED KINGDOM,
IN ITS RELATION TO VACCINATION AND THE VAC-
CINATION-LAWS.

JOHN SIMON,
Medical Department, 1875.

REPORT to the Local Government Board by Dr. Seaton on the Recent Epidemic of Smallpox in the United Kingdom, in its relation to Vaccination and the Vaccination-Laws.

On Smallpox in its relation to Vaccination and the Vaccination Laws.

§ 1.

The epidemic of smallpox which began in England towards the close of 1870 and terminated in the second quarter of 1873 was part of a general epidemic outbreak of that disease, of world-wide diffusion, marked wherever it occurred by an intensity and malignancy unequalled by any previous epidemic of the disease within living memory. The outbreak seems to have begun in France about a year before it manifested itself in the United Kingdom. In the last quarter of 1869, it was already making considerable progress in Paris; early in 1870, it prevailed in Orleans, Bordeaux, Lyons, and other large towns, and in the course of the year extended with great mortality over nearly the whole of France. Except, however, in so far as it was directly conveyed by French prisoners to various places in Germany, there was very little extension beyond France till towards quite the close of 1870. The epidemic then manifested itself in London, in two or three of the chief towns of Holland, in Milan, at Geneva, and in some other places, becoming thereafter rapidly diffused over a great part of Europe. During 1871, England and Scotland, Holland, Hamburg, Prussia and the whole North of Germany, Italy, and Spain felt the full force of the epidemic; and the first beginnings of its ravages were experienced in some of the other countries of Europe, as in Ireland and in Denmark. In the course of this year it spread beyond Europe to various places in Africa (where it raged along the Gold Coast), to the West Indies, and to North America. During 1872, while still continuing its course in most of the countries it had attacked in 1871, it made further extensions over the continent of Europe, invading Austria, Hungary, Russia, and Finland, over Africa, and over North America; it spread also to South America and the South Sea Islands; and it invaded various places in the East. In 1873 the greater part of its course in Europe had been run, but there were yet during the earlier part of the year various countries and districts, and important capitals, as St. Petersburg and Vienna, still under its full influence. By the middle of 1873, however, the pandemic extension of the disease in Europe may be considered to have terminated, and smallpox generally has since then been quiescent, though there have been some considerable local outbreaks.

Course of the late pandemic invasion of smallpox.

In every country attacked, so far as our information extends, the peculiar intensity of this epidemic was manifested by the extreme diffusiveness of the disease, by its attacking in unusual proportion persons who were regarded as protected against the disease, whether by previous smallpox or by vaccination, and by the occurrence with quite remarkable frequency of cases of a malignant and hæmorrhagic type, and a consequent unusually high ratio of deaths to attacks. The actual mortality from the disease in the different countries invaded varied however very greatly, the chief determining influence being, as will be hereafter shown, the state of their respective populations in regard to vaccination.

Its peculiar malignancy.

§ 2.

The recurrence of an epidemic of smallpox in England at the time that this outbreak took place had been anticipated; for the last preceding

Its outbreak in England.

epidemie had terminated at the beginning of 1866, and the period of from three to four years—the utmost time which had heretofore intervened between any two epidemic outbreaks of smallpox in this country—had thus already been exceeded. Previous to the Vaccination Act of 1853, epidemics of smallpox had been of still more rapid recurrence. But from 1853, which was the terminal year of a protracted epidemic, there was no outbreak till 1857, when another epidemic set in which lasted until the end of 1859 or beginning of 1860. This was followed by rather more than three years of very low smallpox mortality, the deaths in 1861 being the fewest that have ever been recorded, viz., 1,320, on a population which was then 20,199, 314, or at the rate of 66 per million of population. In 1863 another epidemic set in which lasted till early in 1866, an epidemic which was of much severity, and caused in the aggregate upwards of 20,000 deaths. The four years which succeeded were again years of very small relative mortality; the smallpox deaths, which in 1867 were only 2,513, and in 1868 only 2,052, further declining in 1869 to 1565, or 72 per million of the then population, a death-rate little exceeding that of the exceptional year 1861.* But at the close of 1869 a gradual rise in the smallpox mortality—the invariable precursor of an epidemic outbreak—set in; and before the end of 1870, as the following table shows, the outbreak was upon us :

SMALLPOX MORTALITY.

	Period.	All England.	London only.
	1869, whole year -	1,565	275
	1870, first quarter -	405	99
	1870, second quarter -	446	118
	1870, third quarter -	500	157
	1870, fourth quarter -	1,229	584

So clearly in fact had this gradual rise in the mortality of smallpox, which at first was most marked in London, been taken as an indication that another epidemic was impending, that in the spring of 1870, the Lords of Her Majesty's Council (with whom then rested the supervision of public vaccination), felt it incumbent on them to give warning of this to certain metropolitan Boards of Guardians who had been negligent in their administration of the Vaccination Act, 1867, and represent to them the consequences which their neglect would surely entail on their respective unions.

Its high rate of
mortality.

The outbreak then was by no means unexpected: but what had not been anticipated, even by the physicians the most experienced in small-

* This sketch applies to the kingdom at large, and not, of course, to each individual part of it at the same time. It often happens that smallpox is epidemic in a particular town, or a particular part of the kingdom, when the kingdom at large is very free from it, and vice versa. Thus, in the epidemic of 1863-5, London was attacked early (in 1863), and contributed largely to the mortality of that year; but in 1864 and 1865, when the disease raged over the country, the smallpox mortality of the metropolis was below the average; whereas in 1866-7, when there was a great subsidence of smallpox in England generally, there was in London a considerable epidemic. In 1869, when smallpox in England was, as shown in the text, almost at its minimum, there was a considerable outbreak in Yorkshire, which division of the kingdom contributed 610 to the 1,565 total deaths of the year. And so, to anticipate a little, in 1874, while the smallpox was very quiescent in the large towns of England generally, it has been very prevalent and fatal in Birmingham.

pox, was the extreme intensity which the outbreak manifested. The varying intensity of different epidemics of the same disease is indeed a well-known fact, and had been illustrated, as regards smallpox, at various times in the Hospital set apart for the treatment of that disease in London: the ordinary mortality of natural smallpox as therein observed, 35 per cent. of the cases admitted, having in certain epidemics been known to mount as high as 47 per cent., and that of post-vaccinal smallpox to increase from 7 to 10 per cent. But no experience which had been acquired in that Hospital had led to the expectation that the ordinary rate of mortality to attacks would by any epidemic influence be nearly doubled. Yet such was the case in 1871 and 1872, in the former of which years the deaths from the natural disease were 66·2 per cent. and in the latter 77 per cent. of the natural cases; or in the two years combined (for the admissions in 1872 were too few to form by themselves a proper basis of comparison) 67·5 per cent. of such cases: while the deaths in the post-vaccinal cases were 15 per cent. This result is stated by Dr. Munk and Mr. Marson, in their report for 1871, to have been due "to the severity of the disease, and especially to the number of cases of malignant smallpox, the proportion of which to other cases has been very largely in excess of anything within the previous experience of either of your medical officers."*

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In the 33 years which, at the time this outbreak commenced, had elapsed from the first establishment in England of a complete system of registration of the causes of death there had been abundant illustrations of the varying fatality of smallpox epidemics; but it had been supposed by many—quite erroneously as it now appears—that that period had been sufficient to exhibit the limits of the fluctuations. Only twice since the close of the great epidemic of 1837–41 had the smallpox deaths in England in any year exceeded 7,000, viz. in 1852, when they were 7,320, and in 1864 when they were 7,684. And though the epidemic of 1837–41, just referred to, had exhibited a mortality enormously in excess of these numbers (the deaths in 1838 alone having been no fewer than 16,268), yet as this was anterior to any vaccination laws, and at a time when the proportion of the population which was unprotected by vaccination was many times as great as it is now, a recurrence of any such considerable mortality as was then observed had been quite outside ordinary calculations. The mortality of the 1870–3 epidemic has not indeed been by any means so great in proportion to population as was that of 1837–41, but it has approached it more nearly than had

Comparison of the mortality with that of other recent epidemics of the disease.

* Report of the Medical Officers of the Smallpox and Vaccination Hospital, London, for the year 1871.—No report was printed for 1872, and I am indebted to the kindness of Mr. Marson for the statistics of that year. No doubt, *severe* cases always find their way in unusual proportion to the Smallpox Hospital, so that its ratio of mortality to cases was higher than in London generally. But even in the Hospitals of the Metropolitan Asylum District, in which the cases admitted would be of a more average character, the ratio of deaths to admissions was extraordinary, amounting to 44·80 per cent. among the unvaccinated, and to 10·15 per cent. among the vaccinated. The ratio in the hospitals of provincial and foreign towns generally has ranged from 40 to 50 per cent. among the unvaccinated, and from 8 to 10 or 11 per cent. among the vaccinated—enormous rates, and attributed everywhere to the same cause, viz: the unusual proportion of malignant, black, and hæmorrhagic cases. In several of these hospitals the rates were as high or higher than in the Smallpox Hospital of London, as in the "Baracken-Lazareth auf dem Templehofer Felde," at Berlin, which were used as additional municipal smallpox hospitals during the epidemic in that city, and in which the mortality among the unvaccinated was 81·25 per cent., and among the vaccinated 14 per cent.; in the Hospital at Leipsic, in which the mortality among the unvaccinated was 71 per cent., and among the vaccinated (including doubtful cases) between 9 and 10 per cent.; and others.

appeared possible. During the 1837-41 epidemic there were registered from July 1st, 1837, to the termination of the epidemic in 1841, 48,012 smallpox deaths in a mean population of $15\frac{1}{2}$ millions;* during the 1870-3 epidemic, 44,433 deaths in a mean population of nearly 23 millions. The proportionate mortality therefore of the epidemic of 1870-3 has been less than two-thirds that of 1837-41.

The progress of the 1870-73 epidemic in England is shown in the following table :—

DEATHS FROM SMALLPOX : EPIDEMIC OF 1870-3.

Period.	All England.	London only.
1870, last quarter -	1,229	584
1871, first quarter -	4,903	2,400
1871, second quarter -	7,012	3,241
1871, third quarter -	4,612	1,255
1871, fourth quarter -	6,380	980
1872, first quarter -	7,720	831
1872, second quarter -	6,521	582
1872, third quarter -	2,953	237
1872, fourth quarter -	1,665	131
1873, first quarter	1,084	46
Total - - -	44,079 †	10,287

By the second quarter of 1873, when the deaths had further fallen to 722, the epidemic may be said to have terminated in England. The smallpox deaths of the last half of that year were but 526; and the smallpox mortality of the entire year was but 2,332, which is much below the annual average.‡

London and Liverpool were among the first places in the Kingdom, and were *the* first places of any importance, to feel the force of the epidemic. Together they contributed 879 to the 1,229 deaths of the last quarter of 1870; and if the smallpox deaths that occurred in them be subtracted from the smallpox mortality of the entire kingdom it will be seen that the apparent decline (as exhibited in the above table) of the epidemic in England in the third quarter of 1871, and its apparent subsequent rise, were simply due to the epidemic having subsided in these two great towns, while it was steadily progressing over the rest of the kingdom.

* The epidemic of 1837-41 was in full force when the system of national registration of births and deaths first came into operation in England, on July 1, 1837; of its earlier ravages therefore we have no account, so that the total number of deaths of the epidemic must have been considerably in excess of the 48,012 stated in the text. In the latter half alone of 1837 the smallpox deaths registered were 5,811; in 1838 they exceeded 16,000; the epidemic then slowly declined throughout 1839 and 1840, causing 9,131 and 10,434 deaths in those years respectively, and did not terminate till 1841.

† These numbers, taken necessarily from the *Quarterly* returns of the Registrar General, are fewer by 354 than the total previously given, in making up which advantage has been taken of the *revised* numbers subsequently published for each year by the Registrar General in his Annual Reports. The Report for 1871 gives 219 smallpox deaths, and that for 1872 gives 135 deaths, beyond those included in the *Quarterly* returns.

‡ The average annual smallpox deaths in England from 1854 to 1870 inclusive were 3,493.

DEATHS FROM SMALLPOX: EPIDEMIC OF 1870-73.

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Period.	England, except London and Liverpool.
1870, last quarter - -	350
1871, first quarter - -	1,441
1871, second quarter - -	3,092
1871, third quarter - -	3,207
1871, fourth quarter - -	5,372
1872, first quarter - -	6,865
1872, second quarter - -	5,923
1872, third quarter - -	2,712
1872, fourth quarter - -	1,528
1873, first quarter - -	1,033

The earliest centres of infection after London and Liverpool were the mining districts in the North of England and in certain parts of South Wales. By the second quarter of 1871 the epidemic had extended to nearly every one of the eleven registration divisions of the kingdom: the York division, however, which was the last attacked, not feeling its influence to any considerable extent till the third quarter of that year. The degree in which each division suffered is shown in the following table.

The mortality
the several
Registration
Divisions;

Division.	Enu- merated Population, 1871.	Smallpox Deaths.		Smallpox Deaths per 1,000 of population.		
		1871.	1872.	1871.	1872.	Mean of the two years
I. London - -	3,254,260	7,912	1,786	2.43	0.54	1.48
II. South Eastern - -	2,167,726	993	1,050	0.45	0.48	0.46
III. South Midland - -	1,442,654	617	878	0.42	0.61	0.51
IV. Eastern - -	1,218,728	759	1,067	0.62	0.87	0.74
V. South Western - -	1,880,777	896	1,142	0.47	0.61	0.54
VI. West Midland - -	2,720,669	1,044	3,838	0.38	1.41	0.89
VII. North Midland - -	1,406,935	554	1,853	0.39	1.31	0.85
VIII. North Western - -	3,389,044	3,597	864	1.06	0.25	0.61
IX. York - -	2,395,569	1,023	2,443	0.47	1.01	0.74
X. Northern - -	1,414,234	4,646	2,040	3.28	1.44	2.36
XI. Welsh - -	1,421,670	1,085	2,133	0.76	1.50	1.13
England - -	22,712,266	23,126	19,094	1.024	0.833	0.928

Thus the South Eastern and South Midland divisions, notwithstanding their dangerous proximity to London, suffered least; the Northern division incomparably the most; next to which came the Metropolis; and then the Welsh division.

The Northern division of the kingdom comprises the counties of Durham, Northumberland, Cumberland, and Westmoreland. But it is to the mining county of Durham and to three unions in Northumberland alone that the division owes its bad pre-eminence. The smallpox death rate of the whole county of Durham in 1871 was 4.52 per thousand; that of the towns of Sunderland and South Shields being nearly the double of this. In 1872 the smallpox death rate of Durham county was 1.87; and the mean of the county for the two years was 3.19, or more than threefold that of the kingdom at large. The great number of deaths in the Newcastle-on-Tyne, Tynemouth, and Morpeth unions in 1871 caused the smallpox death rate in Northumberland in that year to be

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2·95 per 1,000, the following year it was 0·92, the mean of the two years being 1·93, or more than double the rate of the kingdom at large.

So in the Welsh division, the excess of mortality over the average of the kingdom (much less marked than in the Northern division) was due to the mining districts of Monmouthshire and South Wales: the mortality of North Wales was much below the average. The smallpox death rate of Monmouthshire was, in 1871, 1·44, and in 1872, 2·53 per thousand, the mean for the two years being 1·98: in the Bedwellty union it was 3·2 per 1,000 in 1871, and 5·2 per 1,000 in 1872. In South Wales the death rate was 0·76 per 1,000 in 1871, and 1·88 in 1872, the mean being 1·32. The unions chiefly contributory to this high death rate were Pontypridd, Merthyr, Neath, and Swansea. In Pontypridd the smallpox death rate was the highest, amounting in 1872 to 6 per 1,000 of population; the epidemic, however, in this union ran its entire course in this one year, there having been only 7 smallpox deaths in 1871.

The West Midland division, comprising the counties of Gloucestershire, Herefordshire, Shropshire, Staffordshire, Worcestershire, and Warwickshire, would have stood very differently to what it does in the Table but for the mining county of Staffordshire, which, with about a third of the population of the whole division, contributed in 1871 considerably above half, and in 1872 nearly two thirds, of its smallpox deaths.

These facts bring out with great force the urgent need which exists for a more effective sanitary supervision of the mining class of our population.

The following table exhibits the mortality of the epidemic in the 18 chief towns of England:—

Town.	1871.			1872.		
	Estimated Population in the middle of the year.	Total Smallpox Deaths in the year.	Smallpox Deaths per 1,000 of population.	Estimated Population in the middle of the year.	Total Smallpox Deaths in the year.	Smallpox Deaths per 1,000 of population.
London - -	3,263,872	7,912	2·43	3,311,298	1,786	0·54
Portsmouth - -	113,450	39	0·34	115,455	508	4·39
Norwich - -	80,533	245	3·04	81,105	317	3·9
Bristol - -	183,298	45	0·24	186,428	209	1·12
Wolverhampton - -	68,476	284	4·14	69,268	180	2·6
Birmingham - -	344,980	61	0·17	350,164	298	0·82
Leicester - -	95,882	11	0·11	99,143	313	3·15
Nottingham - -	86,929	144	1·65	88,225	205	2·32
Liverpool - -	494,649	1,919	3·9	499,897	50	0·1
Manchester - -	351,488	267	0·75	352,759	75	0·21
Salford - -	125,422	227	1·8	127,923	41	0·32
Oldham - -	(This town first took its place among the "chief towns" in 1872.)			84,004	26	0·3
Bradford - -	146,987	5	—	151,720	32	0·21
Leeds - -	260,657	43	0·16	266,564	268	1·0
Sheffield - -	241,507	406	1·68	247,847	601	2·42
Hull - -	122,266	57	0·46	124,976	216	1·72
Sunderland - -	98,797	850	8·6	100,665	54	0·54
Newcastle-on-Tyne	128,677	695	5·4	130,764	135	1·03

Sunderland, which in 1871 had more than double the smallpox death rate of any town except Newcastle-on-Tyne, still, by a long way, heads the list on a review of the two years combined; then come Norwich, Wolverhampton, Newcastle-on-Tyne; followed, at some considerable interval, by Portsmouth, Sheffield, Liverpool, Nottingham, and Leicester. The lowest average annual smallpox death rate of these ten towns for the two years was in Leicester, where it amounted to 1·6 per thousand. The death rate of the remaining chief towns was considerably smaller.

and in the
chief towns.

The mortality of this epidemic was, as I have said, such as had not been known in England for 30 years, and has at least proved a complete answer, if indeed an answer had been required, to the notion which had of late years been ventilated by some that smallpox was a disease tending naturally to extinction. What was the mysterious "epidemic influence" which caused such peculiar intensity of the disease at this particular time is quite unknown to us. But before proceeding further, it seems very important that it should be noted that the mortality of this epidemic, alarming to us as it has been, has not approached what was the *usual annual* smallpox mortality of the kingdom at the time when vaccination was unknown. The *annual average* smallpox death rate of that period,—not, be it observed, the death rate of a particular year of special prevalence of the disease, but the *annual average* death rate—was more than threefold the death rate of this, in our time quite exceptional, outbreak. The estimated annual smallpox death rate of England in the last century was 3,000 per million of population: the mean annual death rate of this epidemic was 928 per million, having, in 1871, been 1,024, and in 1872, 833 per million. The average annual smallpox death rate of the metropolis in the pre-vaccine period was from 400 to 500 per hundred thousand of population;* the mean annual death rate of this epidemic was 148, having, in 1871, been 243, and in 1872, 54. And if an average be taken of the smallpox mortality of England for the whole 20 years (1854–1873) during which there has been a compulsory vaccination law, *a period which includes the whole of the recent epidemic*, the annual death rate is found to be 245 per million of population, or less than a twelfth of the rate of last century.

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Comparison of mortality of this epidemic with the mortality of last century.

The smallpox deaths in England were 2,332 in 1873, and 2,112 in 1874. In the former of these years some manifestations of the epidemic continued in Birmingham, Leeds, and Portsmouth. In the latter year, Birmingham was the only important town which suffered at all seriously from smallpox. London, since the termination of the epidemic, has enjoyed an immunity from smallpox which is unprecedented. The total deaths from that cause in 1873 were 115, and in the present year (1874) have been 56 only.

The epidemic invaded Ireland towards the end of the third quarter of 1871, and it lasted till the second quarter of 1873. The total smallpox deaths for the years 1871 and 1872 (including 105 deaths which had occurred in the first two quarters of 1871, before the disease had spread as an epidemic), were 3,913, viz., 665 in 1871, and 3,248 in 1872. If to these be added 379 deaths which occurred in the first two quarters of 1873,† we have a total mortality of 4,292 in two years and a half, giving an annual death rate for that period, on the enumerated population of 1871 (5,412,377), of 0·31 per thousand of population. In 1872, the year of severest mortality, the death rate was 0·60 per thousand of population. Belfast and Dublin were in 1871 the Unions which suffered most, contri-

Outbreak of the epidemic in Ireland. †

			Smallpox Deaths per 100,000 of population.
* Average of years 1660–79	-	-	417
„ 1728–57	-	-	426
„ 1771–80	-	-	502

See table by Dr. Farr, p. 10 of "Papers relating to the History and Practice of Vaccination." The increased smallpox mortality towards the close of the last century was attributed to the then prevalent practice of inoculation.

† By the third quarter of 1873 the epidemic had quite subsided, only 30 deaths from smallpox being registered during that quarter. During the present year (1874) there has been a recrudescence of the disease in Ulster, and some extension in Connaught, in which the illegal practice of smallpox inoculation appears to have played a part. The year's mortality, however, from smallpox is below the average of the preceding ten years.

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buting, as appears from the detailed Annual Report of the Registrar General for Ireland, 509 to the 665 smallpox deaths of that year. In 1872 the disease was diffused more or less over the whole of Ireland, with the exception of the province of Connaught. The chief mortality was in the cities of Dublin and Cork. The deaths in Dublin in 1872 were 1,350, and throughout the whole of the epidemic 1,557, or at the rate of 5 per thousand of population, a rate exceeding that of any large English town except Sunderland, Norwich, Wolverhampton, and Newcastle-on-Tyne. The deaths in Cork were 1,873, or at the rate of 9·6 per thousand of population, which is a higher rate than that of any large town in England.

Its outbreak in
Scotland.

The epidemic reached Scotland also in 1871. The detailed returns of the causes of death in that year have not yet been published, but I am indebted to Dr. Robertson, of the General Register Office, Edinburgh, for the information that the smallpox deaths of the year amounted to 1,432, or 0·42 per thousand of the population. The year following, the deaths were much more numerous, but the actual numbers cannot yet be given. Full information, however, for the whole two years, as also for 1873 and 1874, exists concerning the eight chief towns of Scotland. Of these, Glasgow and, to a much slighter extent, Greenock exhibited manifestations of the epidemic influence early in 1871; but such manifestations were of comparatively small amount and short duration, and it was not till the last quarter of 1871 that the force of the epidemic began largely to be felt in any of the towns in question. It continued until the end of June 1872, by which time, in most of them, it had terminated. The smallpox deaths in the eight towns were 886* in 1871, of which 646 occurred between the months of September and December inclusive, and 1,537 in 1872, of which 1,359 were from January to May inclusive; there being only 178 in the remaining seven months of the year. Edinburgh, Leith, Glasgow, Dundee, and Aberdeen were the towns which contributed chiefly to this mortality, as will be seen by the following table:

Town.	1871.				1872.			
	Estimated Population in the middle of the year.	Total Small- pox Deaths in the year.	Small- pox Deaths under five years of age.	Total Small- pox Deaths per 1,000 of popu- lation.	Estimated Population in the middle of the year.	Total Small- pox Deaths in the year.	Small- pox Deaths under five years of age.	Total Small- pox Deaths per 1,000 of popu- lation.
Glasgow -	479,922	180	62	0·37	489,421	148	25	0·30
Edinburgh -	201,766	169	27	0·78	205,009	702	150	3·4
Dundee -	121,535	375	82	3·00	124,817	299	107	2·4
Aberdeen -	88,567	33	4	0·37	90,037	132	21	1·4
Greenock -	60,245	30	9	0·49	62,097	9	3	0·15
Leith -	46,753	82	14	1·76	47,888	222	53	4·6
Paisley -	48,272	3	3	0·06	48,355	9	2	0·19
Perth -	26,378	8	1	0·30	26,417	15	1	0·61
The eight towns -	1,073,608	880	202	0·82	1,094,061	1,537	362	1·41

But though during the latter half of 1872 these towns were mostly free from unusual smallpox mortality, the disease lingered in Glasgow, and during the course of 1873 and early months of 1874 both Glasgow and Greenock, suffered severely enough to show, like Birmingham in England, that the epidemic had not during the two years in which it so extensively prevailed over the kingdom at large completely exhausted

* These are the *revised* numbers as supplied by Dr. Robertson, and differ by six from the numbers given in the Table.

itself nor lost its virulence of character.* In Glasgow, in which the smallpox deaths of the last half of 1872 had been only 51, as against 97 of the preceding half-year, these rose in 1873 to 226, a death rate of 0·42 per thousand of population. In the first four months of 1874 they were 173; in May they fell to 18, and in June to 8, by which time the epidemic in that city may be regarded as over. There had thus been in Glasgow a continuance, with intervals of quiescence, for three years and a half. The total smallpox deaths during that period were 727, giving an annual average death rate of 0·42, for the time the epidemic lasted. Greenock, as the table shows, suffered but little in 1871-2, but it had a sharp outbreak in 1873, the deaths in that year being 198 or 3·2 per thousand of population; a rate equal to that of Dundee in 1871 and of Edinburgh in 1872. There were 21 deaths in January 1874, from which time the disease rapidly declined. In Paisley, there was a small outbreak of about three months' duration, in the spring of the present year (1874.)

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§ 3.

The materials at my command do not enable me to present nearly so complete an account of the mortality of this epidemic on the Continent of Europe as I should have desired, partly because in most of the States statistics of the causes of death are either not kept, or kept very imperfectly, and partly because in many of those States in which systematic records of these causes are kept, the abstracts are not yet completed for the whole period under consideration.† We have, however, quite sufficient information from several of the Continental States to enable us to make an accurate general comparison of the mortality from the epidemic which occurred in them with that which occurred in the United Kingdom.

PRUSSIA was, after France, the first Continental State to feel the force of the epidemic. The disease seems to have been imported there by the French prisoners, who, in the latter months of the year 1870, arrived in large numbers, and were distributed over various parts of the kingdom. This circumstance, together with the general movement among the Prussian population itself which resulted from the war, caused the disease to spread with a rapidity unknown in previous epidemics, and a large portion of the kingdom to be brought speedily under its influence, so that the smallpox deaths of Prussia, which in 1870 were 4,200, rose in 1871 to 69,839, equivalent to a death rate of 2·43 per thousand of the population, or very nearly twice and a half the smallpox death rate of England for the same year. The epidemic continued over Prussia in 1872; of the total mortality it caused during

In Prussia.

* In some at least (of course I have not information as regards all) of the local outbreaks which have occurred in 1873 and 1874, the smallpox has shown the same *malignant character* as it did in 1871-2, a circumstance which is calculated to cause anxiety with regard to future general epidemic extensions, and which should make us doubly careful in maintaining all our defences against this fatal disease.

† The great delay which takes place in this respect is remarked on in several of our Consular despatches. Accurate detailed analyses of large numbers of entries demand, of course, a great deal of time. It is, I am well aware, by accident only that the Abstracts of mortality in England during 1872 did not appear in the summer of the present year (1874), and cannot yet be published; but seldom is much less than a year and a half required even by our own indefatigable Registrar General to get out an Annual Abstract; and the Abstracts for Ireland and Scotland are always much later in appearing than those for England. In fact the Registrar General for Scotland has not yet published the detailed Abstracts of 1871. [As these sheets are passing through the press the Abstracts for England in 1872 and Ireland in 1872 have made their appearance.]

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In Holland.

that year, an account has not as yet been received. For Berlin, however, the statistics are complete for the whole period of the epidemic, which lasted in that city from the latter part of 1870 until July 1872. The deaths from it in 1871 amounted to 5,084, or 6·15 per thousand of population. In 1872 they were 1,100, or 1·33 per thousand of population.* The entire deaths reported for the whole period the epidemic lasted were 6,478, of which 2,837 were in children under five years old.

From HOLLAND, the official information for the whole course of the epidemic, excepting certain details for 1872, is complete.† The force of the epidemic began to be felt in that country in November 1870; of 706 smallpox deaths which occurred in the Netherlands during the whole of that year, no fewer than 553 were in the months of November and December, viz., 126 in November and 427 in December; of the 706 deaths, 293 were in children under the age of five years. The disease then spread rapidly, and in 1871 the total deaths from it in the kingdom amounted to 15,787 (or 4·3 per thousand of population), of which 7,734 were in children under the age of five years. In 1872, the epidemic declined and terminated, the deaths amounting to 3,731 (or above 1 per thousand of population), of which 1,622 were in children under five years of age. The smallpox death rate of Holland in this year of the decline of the epidemic was thus as high as was that of England during the year when the disease amongst us was at its height. The provinces of North Holland, South Holland, and Utrecht, were those which chiefly suffered. The mortality in these provinces in 1871 and 1872 was as follows :—

Province.		Popula- tion at end of 1870.	Total small- pox deaths in 1871.	Small- pox deaths in children under the age of five years in 1871.	Total smallpox deaths in 1872.	Total Smallpox Deaths in 1871 per 1,000 of popula- tion.	Total Smallpox deaths in 1872 per 1,000 of popula- tion.
North Holland	-	587,528	3,009	1,587	713	5·2	1·2
South Holland	-	711,457	7,504	4,138	1,275	10·5	1·8
Utrecht	-	174,775	1,972	820	309	11·3	1·2

The mortality in the chief towns in 1871 and 1872 was as follows :—

Town.		Population, at end of 1870.	Total Small- pox Deaths in 1871.	Smallpox Deaths under five years of age in 1871.	Total Small- pox Deaths in 1872.†	Total Small- pox Deaths in 1871 per 1,000 of population.	Total Small- pox Deaths in 1872 per 1,000 of population.
Amsterdam	-	273,510	2,165	1,281	223	7·9	0·81
Rotterdam	-	123,677	1,701	1,120	6	13·7	0·05
The Hague	-	92,454	1,306	840	10	14·0	0·1
Utrecht	-	60,752	772	418	20	12·7	0·32
Leyden	-	40,009	403	277	5	10·0	0·12
Groningen	-	38,006	227	64	36	5·0	0·94
Amheim	-	32,984	27	11	34	0·82	1·03
Haarlem	-	31,688	12	6	48	0·33	1·51
The eight towns	-	693,080	6,613	4,017	382	9·54	0·55

* Despatch, Aug. 22, 1873, from H.M. Chargé d'Affaires at Berlin, enclosing official account of the smallpox epidemic.

† Despatch, July 4, 1873, from H.M. Minister at the Hague, supplemented by detailed (official) information subsequently forwarded by Dr. Ballot.

‡ The smallpox deaths under five years of age in 1872, though supplied for the kingdom at large in the official information sent, were not supplied for the separate

The official information concerning smallpox in SWEDEN in 1870, 1871, and 1872 tends to show that that kingdom was during those years little affected by the epidemic then raging over the greater part of Europe. There had been, indeed, an epidemic in Sweden during the quinquenniad 1865-1869, and this in 1870 was apparently on the decline. The smallpox deaths for the whole kingdom during 1870 were but 410, and further declined the year following to 230. In 1872 they were of about the same amount, viz., 256. Stockholm contributed to this mortality 104, 111, and 44 deaths in each of these years respectively. But in December 1873 there set in at Stockholm an epidemic, the proportions of which were more in correspondence with those of the recent pandemic outbreak: the deaths in that city having amounted to 618 from December 1873 to April 10 in the present year (1874), at which time the epidemic was described as still raging.* The population of Stockholm is but 143,735, so that evidently its smallpox death rate for this year will be considerably in excess of that of London, or even of that of Liverpool, in 1871.

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In Sweden.

In DENMARK also the mortality from smallpox was not considerable either in 1871 or in 1872. There was however a distinct outbreak, commencing in the former and terminating in the latter of those years. The smallpox deaths of the entire kingdom were 108 in 1871 and 381 in 1872; those of Copenhagen 23 and 218 in the two years respectively. These numbers represent a smallpox death rate per thousand of population of 0·06 for 1871, and 0·2 for 1872 in the whole kingdom, and of 0·13 in 1877 and 1·2 in 1872 in Copenhagen.† Of the 241 deaths in Copenhagen, 85 were in persons under the age of 15.

In Denmark.

In the State of HAMBURG the epidemic set in, as in England and Holland, towards the close of 1870. There were registered in that year 83 deaths from smallpox, of which 56 took place in the months of

In Hamburg.

provinces and towns. If the proportion of these to the total smallpox deaths of the year were the same as in the previous years, they would have amounted in the eight towns to 229. In three of the above towns, viz., Rotterdam, the Hague, and Utrecht, the epidemic began in 1870, so that to complete the account for them there would need to be added to the numbers given in the Table 56 deaths in Rotterdam, 270 in the Hague, and 143 in Utrecht, of which 32, 125, and 62 respectively were under five years of age.

* Despatch, April 14th, 1874, from H.M. Minister at Stockholm. There is a discrepancy, which I am unable to account for, between the number of deaths in 1870 and 1871, stated in Mr. Erskine's despatch, which was supplied him by the Swedish Minister for Foreign Affairs, General Björnstjerna, and is authenticated by Bruzelius the Secretary to the College of Health, and the deaths for the same year, as given by Dr. Guttstadt in his official report on the "Pocken-Epidemie in Preussen," which appear to have been supplied him by Dr. Berg, the head of the Statistical Central-bureau in Stockholm. The following is the information supplied by Dr. Berg, whose figures I give for as far back as from 1855, when the Table given at p. 186 of the "Papers relating to the History and Practice of Vaccination" terminates:—

Year (up to 1870 average of five years).	Population.	Annual Smallpox Deaths (up to 1870, average of five years).	Annual Smallpox Deaths per 1,000 of Population.
1850-54	3,541,717	1,196	0·33 (*)
1855-59	3,704,379	682	0·18
1860-64	3,967,118	419	0·10
1865-69	4,160,467	1,303	0·31
1870	4,168,525	764	0·18
1871	4,204,177	339	0·08

(*) This is the last complete quinquenniad given in Mr. Simon's Tables.

† Despatches from British Consul, October 14th, 1873, and April 26th, 1874.

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November and December. The disease then steadily progressed month by month till August 1871, when the epidemic culminated. The deaths in June, July, and August were no fewer than 1,635, of which 578 were in August. The period of decline then commenced, but the outbreak did not terminate till the spring of 1872. In December 1871 there were 170 deaths; in January 1872, 132; in February, 98; in March, 43; in April, 15; in May, 18; after this only occasional entries are met with. The total smallpox deaths in 1871 were 3,647, or 28·97 per cent. of the year's mortality from all causes; and 10·76 per thousand of the living population (338,974). In 1872 the smallpox deaths were 318.* Of the 3,965 deaths in 1871–2, 1,938 were in children under five years old.

In Saxony.

Our official accounts for SAXONY relate to the city of Leipzig only. In that city the epidemic began and terminated in the course of 1871, the smallpox deaths of 1870 having been only 5, and those of 1872 only 21. But in 1871 they amounted to 1,042, which, in a population of 106,925, gives a death rate of nearly 10 per thousand :† 659 of the deaths were in children under 5 years of age.

In France and Belgium.

No general official records of death-causes exist either for FRANCE or BELGIUM. The only information attainable regards particular places. A despatch received from Brussels, shows that the smallpox epidemic began there towards the close of 1870 and extended into 1871, causing in the former year 224 and in the latter 923 deaths, a death rate on the population of that city of 0·7 and 2·9 per thousand respectively.‡ In Paris the course and mortality of the epidemic were largely influenced by the movements of population consequent on the war, and especially on the siege of that City. Before, however, any of these movements had begun to take place, and even in fact before the war was declared, there had already been from the beginning of November 1869 to the end of June 1870, no fewer than 3,346 smallpox deaths, the disease being at that time rapidly on the increase.§ The recorded deaths from it in 1870 were 10,539; in the first three months of 1871 they were 2,496; the epidemic was then rapidly declining. Of 7,816 deaths which occurred between October 1870 and March 1871 inclusive, 1,600 were among the military.

In Austria.

In AUSTRIA (exclusive of HUNGARY, for which there is no complete return), the total smallpox deaths in 1871 were 7,389, and in 1872, 37,878.¶ These deaths were thus distributed over the respective provinces :—

* Despatches from British Consul-General Annesley, August 25th, 1873, and March 23, 1874.

† Despatch from British Consul-General, August 29th, 1873. [As these sheets were passing through the press, a Despatch was received from H.M. Chargé d'Affaires at Dresden, giving particulars of the smallpox mortality in the kingdom of Saxony in 1870 and 1871. The total smallpox deaths of those years were 7,869; concerning 11 of which it is not stated in which of the two years they occurred, but of the remaining 7,858, the distribution was 743 in 1870, and 7,115 in 1871. Taking the population of Saxony at 2,556,244, the smallpox death rate for 1871 was 2·8 per thousand, being rather higher than that of Prussia, and considerably more than twice and a half as high as that of England for the same year. The return does not extend to 1872. Of the total 7,869 deaths, there is no statement with regard to the age in 796; but 5,270 of the remaining 7,073 deaths were in children under the age of 10 years.—E. C. S., March 9, 1875.]

‡ Despatch from Mr. Lumley, September 6, 1873.

§ Bulletin de Statistique Municipale.

¶ Despatch from His Excellency Sir A. Buchanan, April 18, 1874.

Province.	Population, 1870.	Deaths from Small- pox in 1871.	Deaths from Small- pox in 1872.	On Smallpox in its relation to Vaccination and the Vaccination Laws.
Lower Austria - -	1,990,708	1,169	7,540	
Upper Austria - -	736,557	264	1,045	
Salzburg - - -	153,159	149	309	
Styria - - -	1,137,990	190	771	
Karinthia - - -	337,694	81	121	
Carinola - - -	446,334	58	187	
Triest - - -	600,525	33	915	
Görst and Gradiska - -		18	116	
Istria - - -		17	364	
Tirol - - -		95	101	
Vorarlberg - - -	885,789	28	72	
Bohemia - - -	5,140,544	1,129	8,098	
Moravia - - -	2,017,274	583	3,762	
Silesia - - -	513,404	165	3,133	
Galicia - - -	5,444,683	2,703	10,820	
Buckowina - - -	513,404	545	524	
Dalmatia - - -	456,961	162	?	
Totals - - -	20,375,026	7,389	37,878	

The smallpox death rate for Austria in 1871 on the estimated population of that year was 0·36, and for 1872 on the estimated population of that year, 1·8 per 1,000; but the epidemic, it must be remembered, did not nearly complete its course in those two years, and was very fatal in 1873, for which year no returns have yet been forwarded. The deaths in Vienna in 1871-2 amounted to 3,807. The official returns do not distinguish the ages at death, and state that there are no materials for giving them.

The official returns for RUSSIA extend only to the city of St. Petersburg, in which, between April 13th, 1872, when smallpox was first officially notified, and June 24th, 1873, 1,850 deaths were reported. In Russia, &c.

In ITALY the epidemic extensively prevailed in 1871 and 1872; and in SPAIN and PORTUGAL its ravages were very great. But we have no statistical accounts for either of these kingdoms.*

On a general review of the above statements it will be seen that none of the various countries, concerning which we have precise information, has exhibited so low a rate of mortality from smallpox, during the recent epidemic, as the United Kingdom, with the single exception of Denmark, and with reservation as regards Sweden, where the epidemic has still to complete its course. The death rate of Prussia in 1871 was considerably more than twice as great as that of England; it may be that when the returns of 1872, which we have yet to receive, are added, the disproportion will be somewhat less.† The death rate of Holland for the entire epidemic has been three times as great as that of England: and the difference is still greater on comparison with Ireland.

* It does not come within the purpose of this Report to review the mortality caused by this epidemic in countries, as in parts of the East and of Africa, which are almost wholly unprotected by vaccination; but as affording an example of the ravages of smallpox under such circumstances at the present day, I may refer to the town of Brunei in Borneo, where in a very few months, at the end of 1872 and beginning of 1873, upwards of 4,000 persons were swept off by it in a population of about 35,000 (Despatch from Consul-General Bulwer, February 27, 1873). On the Gold Coast in 1871, smallpox is described by Acting Administrator Salmon as decimating the population. "Nothing," says he, "but the active interference of the local government could have saved the people from annihilation." (Despatch, January 3, 1872.)

† Prussia has swallowed up many States, and among them the former Kingdom of Hanover, always notable for its carefulness as to the vaccination of its population;

§ 4.

On Smallpox in its relation to Vaccination and the Vaccination Laws.

History of the compulsory vaccination laws in the United Kingdom.

About 20 years ago (in 1853) the Epidemiological Society of London communicated to the Home Secretary a report of an extensive inquiry which had been made by them into the "State of smallpox and vaccination in England and Wales and other countries," in which they showed that the then average proportionate smallpox mortality in England and Wales was considerably more than double the smallpox mortality of any of those European States in which vaccination was directly or indirectly compulsory, and that the mortality in Scotland and Ireland was much greater even than that in England. This report, which was subsequently presented to, and printed by order of, Parliament, supplied the arguments on which the first compulsory vaccination law for England, a law which has been since much amended, was enacted in 1853. Ten years later (in 1863) compulsory laws were passed for Scotland and Ireland. And an examination of the provisions and working of these laws will enable us, I think, to explain without difficulty why it is that the United Kingdom now holds among European States a position so entirely different in regard to smallpox mortality to that which it held at the time the Society's report was presented.

Special feature of these laws as compared with compulsory laws on the continent.

The vaccination laws of the United Kingdom require the performance of vaccination at an earlier age than those of any foreign State. It was in fact the main argument of the Epidemiological Society's report, that to establish an effective control over the smallpox mortality of any kingdom, it is indispensable to secure the vaccination of children *in early infancy*. Children are liable to contract smallpox at the very earliest age, and indeed so liable to contract it young, that at the time the report was made no less than from 70 to 80 per cent. of the entire smallpox mortality of Great Britain and Ireland occurred under the age of 5 years, and 25 per cent. even under the age of one year.* Vaccination is as safe an operation in early infancy as at any other period of life. Hence it was obvious that any law which, though directly obligatory, permitted, say, a whole year from birth to pass before requiring vaccination, like the law of Prussia, or two years, like the law of Sweden, must be fundamentally defective and leave an unnecessarily large amount of the young population exposed to the ravages of smallpox; *à fortiori*, that laws which were only indirectly obligatory, as by requiring, for example, a certificate of vaccination before a child could be admitted to school, permitted a still greater waste of life.

The law for England requires that children should (health permitting) be vaccinated within three months from birth, or in rural districts (where public vaccination is only carried on periodically) at the first public vaccination held in the district after the child shall have attained

and it is worthy of remark that of all the provinces of the present Prussian Kingdom the province of Hanover (which comprises, I believe, only part of the former Kingdom of that name) is the one which, in the epidemic of 1871, had the least smallpox mortality. The death rate of the Kingdom being 2.43 per 1,000, that of Hanover was 0.53.

* In countries in which, as in parts of the East, vaccination has only as yet reached a relatively small proportion of the population, the smallpox deaths are *nearly all* in young children. Dr. De Renzy, the sanitary commissioner in the Punjab, says, with reference to the great smallpox epidemic which has prevailed there since 1872, that the deaths are confined almost entirely to young children under 10 years old; *the adults having previously all had smallpox*, with which most of them were scarred, many partially or totally blinded.—(*Lancet*, March 1, 1873, and *Medical Times and Gazette*, July 19, 1873.) In England, before vaccination was known, Dr. Haygarth tells us that in 1781, on examination of the Cheshire and Lancashire Militia, it was found that only one in twenty had not already had the smallpox. (Haygarth, *Sketch of a Plan to exterminate the casual smallpox*. 8vo. Lond., 1793.)

the age of three months. In Scotland and Ireland, in which divisions of the United Kingdom the population is much less aggregated in large towns than it is in England, the age is fixed at six months. The persons affected by the operation of these laws therefore are persons above these ages respectively, who, if born in England were born subsequent to August 17th, 1853, and if born in Scotland or Ireland subsequent to December 31st, 1863—these being the days from which the compulsory laws in the respective divisions of the kingdom first took effect. When the epidemic wave of smallpox reached England towards the close of 1870, it should then, had the vaccination law of 1853 acted according to its full intention, have found the population up to the age of 17 years, except the very youngest, protected against the disease; and it is in the smallpox mortality of persons *under* that age that whatever influence that Act may have had, is to be looked for. In like manner, when the disease extended early in 1871 to Scotland and Ireland, it would be on the population then under seven years of age, and as the epidemic advanced, on those under eight or nine years of age, that the influence of their compulsory vaccination laws would have to be sought.

On Smallpox in its relation to Vaccination and the Vaccination Laws.

There are considerable points of difference in the machinery and provisions of the Acts in force in England, Scotland, and Ireland respectively; and in proceeding to consider, as I purpose now to do, the effect which these Acts have had in diminishing the smallpox mortality in each division of the kingdom, it will be convenient to begin with Scotland on account of the greater precision of our information as to the state of vaccination of young children in this than in either of the other divisions of the kingdom.

(a.) SCOTLAND.—Under the Vaccination Act in force in Scotland, if the successful vaccination, lawful postponement of vaccination, or death of any child on the birth registers, be not registered within six months from its birth, the parent receives a notice requiring the production within a certain time of the necessary vaccination certificate, and, if he do not produce it within that time, becomes liable to the penalties of the law. The annual returns which have been supplied by the Registrar General for Scotland of the working of this law, as respects the children born in Scotland from January 1, 1864 (the date of its commencement) to December 31, 1871 inclusive, show that, after deduction had been duly made of such children as had died before they could be vaccinated, there were, out of every hundred children remaining, ninety-six and a half certified as successfully vaccinated or otherwise protected against smallpox by the time the return for each year was made up, one in whom vaccination was lawfully postponed on account of the child's health, or had been tried so many times unsuccessfully as to justify under the law a certificate of insusceptibility, and two and a half unaccounted for on the registers. These latter cases were, almost without exception, cases which had removed and could not be traced.* Of the $3\frac{1}{2}$ per cent. thus not finally accounted for as protected when the year's return was

Provisions and working of the law in Scotland.

* The exact figures, on the average of the annual returns of the eight years 1864-71 inclusive, are these, the deaths without vaccination each year having been previously deducted: 96·385 per cent. registered as having been successfully vaccinated, and another 0·052 per cent. as having had smallpox, making 96·437 per cent. protected at the date of the return. The unprotected, and those concerning whose protection there is no information, consist of (1) 0·742 per cent. cases postponed by medical certificate, (2) 0·316 per cent. said to be "constitutionally insusceptible" (which means, of course, nothing more than that vaccination has been three times unsuccessfully attempted), and (3) 2·505 per cent. "removed from district before vaccination, or otherwise not accounted for." A subsequent return, for the year 1872, gives as the result for that year 96·861 per cent. as vaccinated, 0·059 as having

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made, many of course would have been subsequently successfully vaccinated.

From this statement it is obvious that that portion of the population of Scotland which at the time the recent epidemic broke out was under the age of seven years, and which is now under the age of ten years, is remarkably well protected against smallpox, but it is almost equally obvious that it is not, and in the nature of things cannot be "universally" vaccinated, nor constitute a class among whom, if smallpox prevail in the country, there could be any reasonable expectation of meeting with *complete* exemption from that disease. For it includes (1) all who are under the age by which vaccination is enforceable, of whom, of course, a very large proportion would be unvaccinated; (2) not a few somewhat above that age, still remaining unvaccinated from the carelessness of their parents in neglecting to have the vaccination done till they had received the legal notice of warning, and risking it probably for some time after that; (3) children in whom there was postponement of vaccination on account of their state of health; and (4) many doubtless still unprotected among the cases which had appeared in each year's return as "postponed," "insusceptible," or "unaccounted for." Now, as there are nearly 120,000 children born in Scotland every year who, until they are six months old, do not come under the operation of the law; as there are about 1,000 of each year's births carried on as postponed, or insusceptible; and as there are about 2,500 annually respecting whom nothing is known, it is quite certain that there must always at any given time be, among the young population of Scotland—extremely well protected as it is on the whole—a considerable actual number of unvaccinated children.

Its effect on
the smallpox
mortality of
children under
the age of five
years;

as compared
with previous
mortality in
Scotland under
that age;

According to the classification of ages adopted by the Registrar General for Scotland in his Monthly Returns of Deaths, viz., those under five years of age, those at 5 to 20 years, those at 20 to 60, and those above 60 years, it is evidently in the first of these classes (those under five years old) that the effects of the Vaccination Act on the smallpox mortality is chiefly to be looked for; the children who in 1871 were between five and seven years of age, or in 1872 between five and eight years of age, constituting but a small portion of that class of the population which are between the ages of 5 and 20 years. Now up to the date of the compulsory law the average annual deaths from smallpox in Scotland among children under five years of age constituted 74 per cent. of the whole mortality from that disease, there being scarcely any variation from the average from year to year. But gradually, from the year 1864 onwards, as the law began to tell upon the young population, this high percentage was reduced, first to two-thirds, then to less than half, till at the end of seven years, in 1871, when the recent epidemic broke out in Scotland, the proportion which the deaths under five years of age bore to the total deaths from smallpox had become considerably less than one quarter, was, in fact, not very much more than one-fifth. The facts for 1871 are shown for the whole of Scotland, and for the groups of districts into which the Registrar General divides that kingdom, in the following table, for which, in anticipation of the detailed Annual Report for that year, I am indebted to the kindness of Dr. Robertson.

had smallpox, 0·747 as postponed, 0·169 as "insusceptible," and only 2·164 as "removed," &c. A comparison in fact of the last three years (1870-2) with the first three years (1864-6) of the working of this Act shows that this working is becoming more and more complete; the cases "removed or otherwise not accounted for" during the later period averaging only 2·332 per cent. per annum, as compared with 2,596 in the earlier period.

SMALLPOX DEATHS IN SCOTLAND DURING THE YEAR 1871.

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Group of Districts.	Total Deaths.	Deaths under five years of age.	Deaths under five years of age, per cent. of total.
Principal towns (with population above 25,000)	886	195	22·0
Large towns (with population from 10,000 to 25,000)	143	32	22·3
Small towns (with population from 2,000 to 10,000)	209	55	26·3
Mainland, rural	183	25	13·6
Insular, rural	11	—	—
Scotland	1,432	307	21·4

Similar information cannot yet be given for any subsequent year, the abstracts not being yet completed, except for the first group of districts, viz., the eight principal towns. But in them the results up to the entire termination of the epidemic at the end of June of the present year are exhibited in the following table :—

SMALLPOX DEATHS IN THE PRINCIPAL TOWNS OF SCOTLAND.

Years.	At all ages.	Under five years of age.	Deaths under five years of age per cent. of total deaths.
1871	886	195	22
1872	1,537	362	23·5
1873	467	124	26·5
1874 (to June inclusive.)*	302	69	22·8
Total 3½ years	3,192	750	23·5

In the General Annual Report of the Registrar General for Scotland for 1872, the results for that year are thus commented on :—“ If the same relative mortality had taken place among children at that age (under five years) as occurred during the previous epidemics, when they were less efficiently protected by vaccination, instead of only 362 children under five years of age having died from smallpox in the eight towns during 1872, 3,370 would have died. The enforcement of the Vaccination Act therefore during the seven previous years appears to have had the effect, in these eight towns alone, of saving the lives of upwards of 3,000 children.”† Applying these observations to the whole period, there will have been a gain in the eight towns of nearly 7,000 lives under five years of age alone. It is then a very moderate calculation indeed that, but for the Vaccination Act, the total smallpox deaths in these towns from the epidemic would

* Only 54 deaths from smallpox were registered in these eight towns in the last six months of 1874.

† Eighteenth Annual Report on the Births, Deaths, and Marriages registered in Scotland during 1872; and Eighth Annual Report on Vaccination, p. 20-1. The Registrar General for Scotland publishes for each year two separate Annual Reports: (1) a General Annual Report, which appears a few months after the year has terminated; and (2) a Detailed Annual Report, which is the really important one for statistical purposes, but which usually does not appear for two or three years later.

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(instead of amounting to only 3,192) have considerably exceeded 10,000.

Conclusions from comparison of the proportions of deaths from a particular disease at different ages require always to be drawn with caution, and with a full knowledge and appreciation of fallacies to which they may be liable. The scale of observation, however, in this case, is so large, and the result is in such exact correspondence with what our knowledge of the protective power of vaccination would lead us to expect, and with what has been the result of similar measures in England and in Ireland, that there can be no hesitation whatever in accepting the above as fairly measuring the effect the compulsory vaccination law has had, during this epidemic of smallpox in Scotland, in saving the lives of young children. It is by no means necessary, however, to rely on this evidence exclusively ; for other proofs are at hand in a comparison of the mortality of young children in Scotland from the recent epidemic with that which has resulted *from the same epidemic* in foreign countries, which have either no compulsory vaccination law, or a compulsory law of a much less complete and effective kind. The places for which our present information is sufficiently complete to afford the material for such comparison with the chief towns of Scotland are Holland, the cities of Berlin and Leipsie, and the State of Hamburgh.

and as compared
with the present
mortality
under that age
abroad.

In Holland.

In Holland there is no general vaccination law, and the only check on the neglect of parents is a rule existing in some communes, and in some only (but by no means always applied, as I am informed, in many communes in which it nominally exists), that children must have been vaccinated before they can be admitted to the communal schools. Hence vaccination is habitually delayed, and children are much more generally than not above two years of age, and repeatedly six, seven, or more years old before they are taken to be vaccinated, if, indeed, vaccination be not omitted altogether.* If now we compare the deaths among children under five years of age in the chief towns of Scotland and Holland from the recent smallpox epidemic, during its two years of greatest prevalence in those towns, the following is the striking result :—

Groups of Towns compared.	Actual Smallpox Deaths under five years of age in the two years.	Smallpox Deaths under five years of age in the two years for equivalent populations of 1,000,000 of all ages.
Eight principal towns of Scotland in 1871 and 1872 (aggregate estimated mean population, 1,083,750) - - - -	557	514
Eight principal towns of Holland in 1870 and 1871 (aggregate population on December 31st, 1870, 693,080) - - - -	4,245	6,122

* Of the primary vaccinations performed in the year 1872, at the Vaccine Institution at Rotterdam, considerably more than half were between the ages of two and ten years ; and I find from a return for 1873 of the vaccinations practised in the different provinces of Holland, that out of a total of 133,931 vaccinations and revaccinations performed, there were but 31,843 under two years of age ; 82,433 were in children between two and 10 years old ; and the remainder in persons above 10 years old. (Verslag over het Geneeskundig Staatstoezicht over 1873, p. 139.)

As, however, the epidemic continued, though with much diminished force, both in the towns of Scotland and of Holland beyond the periods comprised in the above table, it is necessary, and the more so that *relatively* the subsequent mortality was greater in the Scotch than in the Dutch towns, to extend the comparison, as accurately as we can, to the entire termination of the epidemic in each group. For the Scotch towns the figures are complete; and to the 557 deaths under five years of age in 1871 and 1872, we have to add 193 which occurred up to the end of June 1874. The returns from Holland, however, for 1872 are so far incomplete, that while showing a total of 382 smallpox deaths in the eight towns, they do not give the number of those deaths which were under five years of age. If, however, we assume the proportion to have been the same as in the two preceding years (and in this we cannot be far wrong), there would be 229 to be added to the 4,245 in the table, making the entire number for the three years 4,474; and the comparison would stand thus:—

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Groups of Towns compared.	Actual (or estimated) Smallpox Deaths under five years of age in the entire periods compared.	Smallpox Deaths under five years of age in the entire periods compared for equivalent populations of 1,000,000 of all ages.
Eight principal towns of Scotland during the 3½ years the epidemic subsisted - -	750	692
Eight principal towns of Holland during the 3 years the epidemic subsisted -	4,474	6,455

In Hamburgh, as in Holland, there was not, at the time of this outbreak of smallpox, any compulsory vaccination law, nor any check on the negligence of parents except a requirement of certificate of vaccination before a child could be admitted to the "schools of the poor." In Saxony also, there was no direct compulsory law. In Prussia, however, such a law existed; and as its provisions have apparently been much misunderstood in this country, it is important they should be explained. This law required that children should be vaccinated within one year of birth, *without, however, attaching any penalty to neglect, except in the cases in which smallpox followed such neglect.* But these were the very circumstances under which there was a natural indisposition to prosecute; technical difficulties also not unfrequently arose about the prosecution; and the result was that prosecutions were seldom undertaken, and that while by most parents the law was duly obeyed, a great many were in the habit of risking it. The number of these latter had, as Dr. Guttstadt informs us in his official report, of late years considerably increased. Hence, when this epidemic broke out, large numbers of children were found in Berlin who had attained school age without vaccination having been performed;* and it was to this accumulation of unvaccinated children that the high mortality of the epidemic in that city was, according to Dr. Guttstadt, in great measure attributable. When children in Prussia had attained the age for admission to the State

In Hamburgh, Leipsic, and Berlin.

* Zeitschrift des Königlich Preussischen Statistischen Bureaus, 1873, p. 152. Laws for rendering the performance of vaccination directly compulsory have since been passed, I believe, both for Prussia and for Hamburgh.

schools, an important check came into operation, for they had then to produce the certificate of having been vaccinated.

Our information for Hamburg, Leipsic, and Berlin supplies the ages at which the smallpox deaths occurred, and embraces for each of those places the whole period of epidemic prevalence. A comparison with the town populations of Scotland and Holland gives the following results:—

Towns or groups of Towns compared.	Actual Smallpox Deaths under five years of age during the whole period of the epidemic in each town or group of towns.	Smallpox Deaths under five years of age during the whole period of the epidemic for equivalent populations of 1,000,000 of all ages.
Eight principal towns of Scotland (population, 1,083,750), 1871-4 - - -	750	692
Berlin (population, 882,569), 1871 and 1872	2,837	3,448
Hamburg (population, 338,974), 1871 and 1872 - - - - -	1,938	5,717
Leipsic (population, 106,925), 1871 - - -	659	6,200
Eight principal towns of Holland (population, 693,080), 1870-2 - - -	4,474	6,455

The position occupied by Berlin is, as might be expected, intermediate between that of the Scotch Towns on the one hand, and Hamburg, Leipsic, and the Dutch towns on the other.*

I regret that I have not the materials for comparing the smallpox mortality under five years of age in all these various towns or groups of towns with *the population living under that age* in them respectively. The only places for which I can do this are the towns of Scotland, Berlin, and Leipsic. The population living under five years of age in the eight towns of Scotland in 1872, the mid-period of the epidemic in that kingdom, was 147,433; the smallpox deaths under five years of age in the $3\frac{1}{2}$ years were 750; the annual rate was therefore 145 per hundred thousand children living under that age, continued for a period of $3\frac{1}{2}$ years.† The population living under five years of age in Berlin in 1871-2 was 88,093; the smallpox deaths in these years under five years of age were 2,837; the annual rate was therefore 1,600 per hundred thousand children living under that age, continued for a period of 2 years. The population living under five years of age in Leipsic in 1871 was 8,545; the epidemic began and ended in that year. Taking for comparison (as appears to me the correct way) the *entire* period of

* In some foreign towns the military form a large proportion of the population. It from the population of Leipsic in 1871, as given in the text (106,925), the soldiers be deducted, the remaining inhabitants were only 89,326 in number. As it was among these that all the deaths under five years of age occurred, the proportion per million might more correctly be put down as 7,377 than as 6,200. This proportion, though higher than that of the Dutch towns in the aggregate, is not so high as that in some of them, for in Rotterdam the rate was 9,045, and at the Hague, 10,437 per million. (See L. Thomas, Beiträge zur Pocken-statistik inbesoudere aus der Leipziger Epidemie, von 1871, in Archiv der Heilkunde, 1872. Dr. Thomas gives the smallpox deaths under five years of age in Leipsic as 680; but I adhere to the numbers (659) officially supplied to our Government, and have made my calculation accordingly.)

† In 1872, the year of *chief* prevalence of the epidemic, the smallpox deaths under five years of age did not exceed 245 per 100,000 children living under that age.

the epidemic in each place, and reducing the numbers to a common ratio, the account stands thus—

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Towns or groups of Towns compared.	Population living under five years of age.	Smallpox Deaths under five years old during the entire period of the epidemic in each place.	Smallpox Deaths under five years of age during the whole period of the epidemic for equivalent populations of 100,000 children under that age.
Chief towns of Scotland (3½ years) - -	147,433	750	508
Berlin (2 years) - -	88,093	2,837	3,200
Leipzig (1 year) - -	8,545	65	7,712

So far then as comparison on the basis of special age rate, which is the best to take wherever it is attainable, differs from that made on the other and more generally attainable one, the difference is more marked in favour of the towns of Scotland.

As Dundee was the town which of all the chief towns in Scotland had the highest proportionate infantile mortality from smallpox, it is necessary for completeness of our comparison to examine in detail the particulars respecting it. The mean population of Dundee for the two years during which it was subject to the influence of the epidemic (1871 and 1872) was estimated at 123,176, the population under five years of age being about 16,700; the average annual births of the two years were 4,597. The population is a rapidly increasing one, and there is much immigration. The epidemic struck the place with great severity, causing in the two years 674 deaths, of which 485 were in persons over five years of age and 189 in children under that age. The proportion of smallpox deaths under five years of age to the total smallpox mortality was therefore 28 per cent.; their ratio to the general population of the town for the whole period of the epidemic, 1,534 per million; and their ratio to the population living under five years of age 1,140 per hundred thousand. How far this excess of juvenile smallpox mortality over that of the towns of Scotland generally might be due to any local laxity in the administration of the acts (for of course the law is not everywhere administered with equal precision); how far it might be due to immigration of parents with unvaccinated children from other parts of Scotland (portion, for instance, of the 2½ per cent. of births annually lost sight of), or from England, or from Ireland; how far to excessive exposure of the young infants to infection from overcrowding, &c.—all these are matters which could only be properly determined by local inquiry. What it concerns us particularly to note in connection with our present argument is, that even in this town, in which the juvenile smallpox mortality was proportionally the greatest, the ratio of deaths under five years of age to population living under that age was not very much more than a third that which occurred in Berlin (1,140 per hundred thousand as compared with 3,200 per hundred thousand), and not very much more than a seventh that which occurred in Leipzig (7,712 per hundred thousand): while the ratio of the smallpox mortality in the three towns among persons *above* five years of age was very nearly the same in each. So also with regard to those foreign towns, the comparison

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with which I am obliged to base on the ratio which the deaths under five years of age bear to *the whole* population, the proportion of these in Dundee (1,534 per million) was little more than a quarter that of Hamburg, not nearly a quarter that of the chief towns of Holland taken collectively, about a sixth that of Rotterdam (9045 per million), and less than a seventh that of the Hague (10,437 per million).

The proportion of the population of Scotland above five years of age which has been born since the Vaccination Act came into force is at present small; but it augments year by year, and in the course of years an almost entirely vaccinated population will, if I may so say, have been *built up*. Already the proportion is sufficient to have made a noticeable difference in the relative number of smallpox deaths occurring among those above 5 and under 20 years of age on the one hand, and among those above 20 years of age on the other.* Up to the year 1864, 49 per cent. of those smallpox deaths in Scotland which occurred above five years of age took place between the ages of 5 and 20 years, and 51 per cent. over 20 years; but from 1871 to 1873 only 40 per cent., and in the last of those three years (1873) only 33 per cent., were between 5 and 20 years of age, the proportion above 20 years of age being 60 per cent. and 67 per cent. respectively.

The number of deaths which occurred from this epidemic in the eight chief towns of Scotland taken in the aggregate at ages *above* five years (2,442) was smaller, and even considerably smaller, proportionately to population, than that which occurred in the corresponding group of towns in Holland; and this holds good, though to a less extent, if the comparison be made between the towns in each kingdom which were the most severely stricken. Thus, if Edinburgh, Dundee, and Leith—the three towns in Scotland which had the highest rate of smallpox mortality—be compared with Rotterdam, the Hague, and Utrecht, the smallpox deaths *above* five years of age per million of total population were in the former 3,412, 3,937, and 5,008 respectively, and in the latter 5,634, 6,008, and 7,160 respectively. The mean of the former (4,119) corresponds very nearly with the rates in Berlin (4,426) and Leipzig (3,572),† where there is, I believe, strict application of the rule requiring vaccination before children can enter the schools: that of the latter (6,407) is somewhat higher than the rate for Hamburg (5,980). The favourable position of the Scotch towns in comparison with these latter towns is doubtless in great measure due to the number of protected *children above* five years of age in Scotland, the result, direct and indirect, of the Compulsory Vaccination Act. But whatever difference may be noticeable between the towns of Scotland and the towns abroad in regard to smallpox deaths *above* the age of five years, this, it will be observed, is quite insignificant in comparison with the difference in regard to deaths *under* that age. It is the practice of vaccination in Scotland *in early infancy* which has been the main cause of the comparatively small mortality which that kingdom has suffered during the recent epidemic.

Provisions and
working of the
law in Ireland.

(b.) IRELAND.—The Compulsory Vaccination Act for Ireland came into operation at the same date as that for Scotland. As it is without

* There is every probability that the effect of the Compulsory Vaccination Act in Scotland was not wholly limited to the children born subject to its provisions, but that, as is known to have been the case in England and Ireland, it extended to many of the children previously born.

† A rate which, it must be observed, would have been about 4,200 but for the large proportion of military, who having been all, or nearly all, *revaccinated* had scarcely any smallpox mortality.

that effective machinery for registering compliances which the Scotch Act provides, it is impossible to give the same systematic account of its working from year to year. We must put up with the best approximate evidence that can be got; and this is quite sufficient to show on the whole a remarkable degree of success, not, however, without some serious drawbacks. The vaccination of Ireland is chiefly done, and probably except in towns of some size almost wholly done, by the Public Vaccinators, who of course supply to the Local Government Board for Ireland (formerly to the Poor Law Commissioners for Ireland) annual returns of their proceedings. From comparison of these annual returns with the registered births for the eight years from 1865 to 1872 inclusive, it appears that upwards of 81 per cent. of the births were vaccinated by the public vaccinators, the births registered during those years having been 1,179,714, and the public vaccinations performed during the same years *of children born since January 1, 1864*, having been 962,660. But as the registration of births in Ireland is far from complete, the proportion of public vaccinations to *actual* births must be less than that above indicated; and probably the residuum to be accounted for would be much nearer 24 or 25 per cent. of the children born than the 19 per cent. left on the above statement. This residuum would comprise all the children who had died without having been vaccinated; all who had been vaccinated by private practitioners (and these, at least in towns such as Dublin, Belfast, Cork, &c., would amount to a considerable number); all whose vaccination had been lawfully postponed; and an indeterminate number who would unlawfully have remained unvaccinated. The public returns disclose one great blot which has been severely commented on by the Commissioners, viz., that in a large number of cases the vaccination, which should have been performed within six months of birth, does not take place till the children are more than a year old. In 1872 there were no fewer than 33,440 cases of children under the provisions of the Act who were not vaccinated till they were more than a year old; and in 1873 there were 19,258 such cases. One necessary result of this is that the proportion to be told off each year as having died without vaccination is very much larger than the $8\frac{1}{2}$ per cent. which is the ascertained average of such cases in Scotland, or the $9\frac{1}{2}$ per cent. which was returned for England in 1872. There can be no reasonable doubt, I think, that of the 24 or 25 per cent. of the annual births of Ireland not vaccinated by the public vaccinators, more, and perhaps considerably more, than one half may be put down as having died without vaccination. It would be mere guess work to estimate, of the remaining 10 to 12 per cent. or thereabouts, how many had been vaccinated or how many might have escaped vaccination. But as in this remnant all the private vaccinations done in the kingdom are included, it is very certain that a considerable portion must have been vaccinated.

Evidently then the Vaccination Act for Ireland does not work with the same precision as that for Scotland. Not only is its machinery radically defective in not providing an efficient system of registration, but for want of local officers whose prescribed duty it is, as in Scotland and in England, to warn each parent when the limit of time fixed for compliance has been attained, and to take the necessary steps then for seeing that the vaccination is duly performed, there is a great deal of dangerous postponement and neglect. With these defects it is more surprising to note what the Act has accomplished than what it has failed in, and the general success which, under the energetic administration of the Commissioners, it has achieved.

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The following is the estimate, which the Commissioners, writing in the spring of 1871, in immediate anticipation of the extension to Ireland of the great smallpox epidemic, already widely prevalent in England, give of the state of protection of the Irish population. "It should," they say, "constantly be borne in mind that notwithstanding the satisfactory progress, with the exception of one year, of infant vaccination since 1864, there is still a considerable number of children born each year remaining unvaccinated; and that among the population born before 1864, there is a larger proportion than of infants unprotected. It is certain that if any of these come in contact with and contract this most contagious disease it will destroy life in a very considerable proportion of the cases of attack."* There can be no doubt that in 1871 and 1872 great energy was displayed in clearing away arrears which had existed. The general distribution of the population of the country, so small a relative proportion of which is concentrated in towns, was favourable to this being done in most places in time to prevent serious danger. But a risk was run which need not have been, and should not again be, encountered. A few simple alterations of the machinery of the law would prevent that constant recurrence of arrears which, from the vaccination returns of 1873, it is evident is still going on, and which, while it is permitted, must be a constant source of anxiety and danger.

Before the Vaccination Act of 1863 the neglect of infantile vaccination in Ireland had been extreme. At the time the Epidemiological Society made its report in 1853, 79 per cent. of the smallpox mortality of that country was in children under the age of five years; and though, under the Medical Charities Act and an Act subsequently passed in 1858, there had been, through the instrumentality of the Public Vaccinators, an increase since then in the amount of vaccinations performed, this had not been sufficient to reduce the proportion of smallpox deaths under five years of age below 75 per cent. up to the time when the Compulsory Act of 1863 came into operation. In 1865 and 1866, by the operation of that Act, the proportion declined to about 50 per cent. The next four years were years in which smallpox was almost entirely absent from Ireland. But when the disease returned in 1871, by which time the population up to seven years of age had come within the provisions of the compulsory law, the proportion of smallpox deaths under five years of age was found to have fallen to about the same extent as those in Scotland under the operation of a similar law:

SMALLPOX DEATHS IN IRELAND DURING THE YEARS 1871 AND 1872.

Year.	At all ages.	Under five years of age.	Deaths under five years of age, per cent. of total deaths.
1871 - -	665	135	20·5
1872 - -	3,248	821	25
Total - -	3,913	956	24·4

* Twenty-fourth Annual Report of the Commissioners for administering the Laws for the Relief of the Poor in Ireland, p. 38.

Its effect on
the smallpox
mortality of
children under
the age of five
years,

as compared
with former
mortality in
Ireland under
that age,

In the City of Dublin, in which the total deaths from the epidemic in the two years during which it prevailed were 1,557, the number of those deaths under five years of age was 362, or 23 per cent., about the same proportion as in the principal towns of Scotland. I am unable to give the proportion which these 362 deaths bear to the population living under five years of age ; but their proportion to the total population of Dublin (314,666) represents 1,150 deaths from the entire epidemic per million as compared with 692 in the eight principal towns of Scotland taken together, 1,534 in the town of Dundee, 3,448 in Berlin, 5,717 in Hamburg, 6,200 in Leipsic, and 6,455 in the chief towns of Holland.

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and with present mortality under that age abroad.

The effects of the Compulsory Vaccination Act for Ireland were not limited to the children born subject to its provisions. "The Act," say the Commissioners, "though applying in its compulsory provisions only to children born [on or] after that date [Jan. 1, 1864] was practically accepted as imposing an obligation in regard to children born previously ; and in the first year a large number of persons, viz., 166,456 not really within the scope of the Act were vaccinated under it [by the public vaccinators], and in succeeding years this operation continued ; and this class of subjects, although necessarily diminishing each year, is still a considerable one."* To this result, no doubt, the existence of a system of public vaccination, for the performance, at the public cost and without any expense to individuals, of vaccination on all who duly apply for it at the public stations, by vaccinators whose rate of payment is regulated by the number of vaccinations done by them, largely contributed. Thus year by year the population of Ireland has been rapidly becoming a more and more protected one ; and the consequent decline exhibited in the smallpox mortality of the kingdom affords probably the most remarkable example that exists of what sound legislation and good administration may effect in the saving of human life.

A little more than thirty years ago, at the census of Ireland for 1841, smallpox was ascertained to have been the second most fatal disease in the kingdom during the preceding ten years. The deaths from it in that period had been no fewer than 58,000. At the census of 1851 it was found to have been the third most fatal disease. The annual average deaths from smallpox in Ireland for 19 years preceding the Act of 1863 were, as shown in a table given in the Twenty-first Annual Report of the Poor Law Commissioners for Ireland, 2,644, the highest number of deaths in any of those years having been 6,436, and the lowest, 863.† The Compulsory Vaccination Act of 1863 came into operation at the decline of a considerable smallpox epidemic, and during the first year of its operation, before there was time for its results to be more than very partially manifested, the smallpox deaths were 854. From that time they declined in a manner without precedent in the history of Ireland to 347, 187, 20, 19, 20, and 32 in the six years from 1865 to 1870 inclusive. In 1871 the first wave of the recent epidemic was felt, causing the deaths to rise to 665 ; in 1872 they rose further to 3,248. In the first two quarters of 1873 they had declined to 379, and in the next quarter the epidemic had virtually ceased, the deaths registered during that quarter (the third of 1873), being 30 only. In comparing the smallpox mortality of the two periods before and after the compulsory Act, the decrease of population which has gradually been

General effect produced by the compulsory law on the smallpox mortality of Ireland.

* Twenty-first Annual Report of the Commissioners for administering the Laws for Relief of the Poor in Ireland, page 31.

† Ibid.

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going on in Ireland must be borne in mind, and in the subjoined table* and accompanying diagram I have made the necessary correction for this. The upper line on the diagram shows what the actual mortality for each of the years compared was; the shaded portion what proportionately it would have been had the population of the year been the same as the population of 1871. It will be seen that the *average annual* smallpox mortality of the period since the compulsory law came into operation, *including the recent epidemic*, has not been nearly a third of the (corrected) annual average of 19 years previous, and has not, in fact, approached the lowest mortality exhibited in any one of those years; or, taking the last 10 only of the 19 years, and thus excluding the great epidemic of 1846-50, that it has not been even half the annual average of those 10 years, nor approached the lowest mortality exhibited in any one of them. The 4,292 deaths caused by the recent epidemic itself were not nearly a quarter of those (18,387 as corrected for population) caused by the epidemic of 1846-50. These 4,292 deaths were spread over two and a half years, and are equivalent to an annual average of 1,717 deaths for the time the epidemic lasted,—a number which, if com-

* TABLE showing the annual smallpox mortality of Ireland for two periods: A, for 19 years previous to the Compulsory Vaccination Act; B, for 10 years subsequent to that Act: with correction each year for diminution of population.

A. 19 years previous to Compulsory Act.			B. 10 years subsequent to Compulsory Act.		
Year.	Actual Smallpox Deaths.	Estimated Smallpox Deaths if population of each year had been the same as in 1871.	Year.	Actual Smallpox Deaths.	Estimated Smallpox Deaths if population of each year had been the same as in 1871.
1842	2,743	1,801	1864	854	816
1843	2,682	1,758	1865	347	332
1844	2,453	1,598	1866	187	182
1845	3,045	1,980	1867	20	19·6
1846	3,730	2,428	1868	19	18·7
1847	5,197	3,494	1869	20	19·8
1848	5,750	4,060	1870	32	31·8
1849	6,436	4,785	1871	665	665
1850	4,634	3,620	1872	3,248	3,261
1851	1,865	1,544	1873	481	481 (a)
1852	1,767	1,504	Average of 10 years		583
1853	1,419	1,228			
1854	1,510	1,339	(a) I have not the data for making estimate for this year.		
1855	1,466	1,314			
1856	1,651	1,491			
1857	1,084	988			
1858	903	827			
1859	1,048	963			
1860	863	799			
Average of 19 years		1,972			

The number of deaths, however, given for period A is very far short of the number which actually occurred within the period, for it is simply the number which, on inquiry at each decennial census, was ascertained to have died of smallpox during the preceding decennium, and, as the Census Commissioners observe, does not include the deaths which had taken place in families who in the course of the ten years had emigrated or died out, or who had ceased to be independent occupiers. Systematic death registration was established in Ireland in 1863, and the numbers for period B are from the Registrar General's returns. There is no return of deaths in Ireland for the years 1861 to 1863 inclusive, but, as stated in the text, smallpox was during those years severely fatal.

pared with *the annual average of the whole of the former period*, made up as it is of epidemic and non-epidemic years, falls considerably short of it. When the peculiar intensity of the recent epidemic is borne in mind, an intensity which, as the hospital records of Ireland show, was not less manifested there than elsewhere in the large proportion of malignant, black, and hæmorrhagic cases, these results must certainly be regarded as very remarkable.

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But that these deaths would have been still much fewer had there been that complete state of vaccination which it is the purpose of the law to attain, no reasonable person can doubt. The Commissioners' statement that, apart from the delay in the vaccination of young children, there are many adolescents and adults still unprotected, must not be lost sight of. If these be aggregated in any place, they constitute a great danger to that place, and whenever the infection of smallpox finds its way in, a high local death-rate from that cause may be expected to ensue.

(c.) ENGLAND. The Compulsory Vaccination Act of 1853 was to a considerable extent an experimental Act, and was very imperfect in its provisions. The machinery provided by it for the registration of compliances was inefficient, so that no precise statement of its effects in securing the vaccination of young children can be given; and it did not specifically impose on any local authority the duty of seeing that its requirements were carried out. Still there is abundant evidence of its having been largely effective. The mere fact that the law required the vaccination of children to be done within a prescribed period from birth, and if it were not so done, rendered parents liable to a penalty, was sufficient to induce compliance on the part of the bulk of the population; and the number of *infantile* vaccinations annually performed by the Public Vaccinators (by whom in England much the greater part of all the vaccination of the country is done) was at once and permanently doubled. The result on the smallpox mortality of the kingdom was seen in a speedy diminution of the average annual death rate; and the smallpox deaths under five years of age, which up to 1853 had constituted 75 per cent. of the deaths from that cause at all ages, were in a very few years reduced to 55 per cent.; the proportion in Ireland and Scotland remaining at 75 per cent., as we have seen, until 10 years later, when those divisions of the United Kingdom also came under a compulsory vaccination law. From the point thus attained in England no further reduction in the proportionate juvenile mortality from smallpox took place until the Acts of 1867 and 1871. By the former of these Acts (the Vaccination Act, 1867), which came in force on the 1st of January 1868, a proper machinery for registering compliances with the law was established: and the respective Boards of Guardians throughout the kingdom were required to see that such compliances took place, and *authorized* to appoint officers whose duty it should be to institute inquiries, issue warnings, and take proceedings for that purpose. By the latter (the Vaccination Act, 1871), they were *required* to appoint such officers. When the recent smallpox epidemic burst forth, towards the end of 1870, only a portion of the population under five years of age in England was within the operation of the Act of 1867; during the continuance of the epidemic a larger proportion came under its provisions, and some came also under the provisions of the Act of 1871. The result was manifested in a reduction of the proportionate smallpox mortality under five years of age from 55 per cent. of the entire mortality from that cause to 33½ per cent. in 1871, and to 30 per cent. in 1872.

Provisions and working of the laws in England.

Effect of the law of 1853 on the smallpox mortality under the age of five years.

Further effect of the Acts of 1867 and 1871,

On Smallpox in
its relation to
Vaccination and
the Vaccination
Laws.

illustrated by
reference to the
Metropolitan
unions :

The Act of 1867, being in some of its most important requirements permissive only, had been carried out with very various degrees of efficiency by different local authorities. In those places in which the action taken under it had been tardy and ineffective, the mortality in the young children amounted to, or approached, its old proportions: in those places in which such action had been commenced immediately on the Act coming into operation, and been steadily continued, a remarkable diminution in that proportion was observed.

Respecting, first the Metropolis, the accompanying table, (for the means of constructing which I must express my great obligation to the Managers of the Metropolitan Asylum District, and to Mr. Marson of the London Smallpox and Vaccination Hospital,) by distributing the smallpox deaths which occurred in the various hospitals of London to the unions from which the cases were sent in, shows to what extent each union contributed to the general mortality from that cause, and what in each was the proportion of deaths under five years of age. In one union only, that of Bethnal Green, did this proportion remain at the average of the period preceding the Act of 1867: this was a union which had been the subject of repeated official remonstrances for its neglect properly to carry that Act into effect, and which indeed did not till quite a late period of the epidemic take really effective steps for the purpose.* Another union, St. George's, Southwark, would have shared the unenviable position of Bethnal Green, but that by its incorporation in the St. Saviour's Union shortly before the smallpox outbreak, its high relative juvenile mortality is not exhibited in the table. "We've done nothing, sir, and we don't intend to do anything," was the reply of the Clerk of St. George's, Southwark, to the inquiries made of him as to steps taken in administration of the Vaccination Act of 1867: in this division of the St. Saviour's Union the smallpox deaths under five years of age in 1870 and 1871 were 60 per cent. of the whole. The unfavourable position, again, which St. George's, Hanover Square, holds in the table among the western group of unions is chiefly due to the then recent incorporation with it of the former union of St. Margaret and St. John, Westminster, in which, beyond the voluntary action of one of the registrars, no steps in execution of the Act of 1867 had been taken.

Except Bethnal Green, every one of the metropolitan unions, as at present constituted, exhibited a marked diminution in the proportionate smallpox mortality among young children as compared with that existing before the Act of 1867. Putting aside Bethnal Green, the deaths under five years of age ranged in the respective unions from 43·4 to 28·6 per cent. of the whole smallpox mortality in the more strictly Metropolitan Unions, and to a less proportion than this in the suburban Unions of Lewisham and Hampstead: the proportion for the entire metropolis being 36·7 per cent. The saving of young life which this reduced proportion implies is very great; and it would obviously have been much greater than it actually was, had the law of 1867 been from the first efficiently administered over the whole metropolis, and had it been long enough in operation to bring within its influence children up to the full age of five years. In regard to this latter point the Vaccination Officer of St. Luke's, Middlesex, a division of the Holborn Union, in which the Act of 1867 had been administered with great efficiency, and in which

* I speak, it must be fully understood, historically. I am not aware that there is any subject for complaint in the present administration of the Vaccination Acts in Bethnal Green.

f the YEARS 1871 and 1872,

Hospital.	Persons under of age.	Proportion per cent. of Smallpox Deaths under five years of age to Smallpox Deaths at all ages in 1871 and 1872.	Total Smallpox Deaths in 1871 and 1872 (com- bined) per 1,000,000 of population.	Smallpox Deaths under five years of age in 1871 and 1872 (com- bined) per 100,000 children living under that age.	UNION.
	Total.				
P -	31	30.4	1,585	399	Paddington.
K -					Kensington.
F -					Fulham.
Cl -	12	28.6	2,462	579	Chelsea.
St -	2	40.0	3,046	1,231	St. George, Hanover Square.
W -	5	29.4	1,329	383	Westminster.
M -	27	34.4	2,122	692	Marylebone.
H -	3	14.8	2,509	346	Hampstead.
Pa -	33	33.2	3,883	1,009	Pancras.
Isl -	20	30.4	2,441	554	Islington.
H -	54	30.8	4,290	1,215	Hackney.
St -	4	35.8	1,979	645	St. Giles.
St -	2	32.2	2,104	693	Strand.
H -	29	28.9	2,746	613	Holborn.
Cit -	14	32.6	2,145	724	City of London.
Sh -	15	41.8	4,860	1,414	Shoreditch.
Be -	69	55.7	5,462	2,012	Bethnal Green.
Wi -	13	42.6	3,369	1,137	Whitechapel.
St -	3	36	2,539	668	St. George-in-the East.
Ste -	10	31.5	2,461	592	Stepney.
M -	14	35.2	2,834	680	Mile End Old Town.
Pop -	84	37.9	3,695	912	Poplar.
St -	54	43.4	4,239	1,346	St. Saviour's.
St -	12	37.5	3,031	759	St. Olave's.
La -	47	30.3	3,138	708	Lambeth.
Wa -	12	39.9	4,206	1,193	Wandsworth.
Ca -	23	33.0	2,524	591	Camberwell.
Gre -	21	37.8	1,630	444	Greenwich.
Le -	3	18.4	737	109	Lewisham.
Wo -	21	38.2	1,499	415	Woolwich.
Pat M SL S	—	—	—	—	Patients from extra- Metropolitan Unions sent to London Smallpox Hospital.
V	636	36.7	2,970	847	
					Whole Metropolis.

* * *
e in the Return from the Asylum District the deaths which
Returns both from the Asylum District and from the London
e year. The smallpox deaths, therefore, in the Table for 1871
are calculated on the basis of the population of the Metropolitan

On Smallpox in
its relation to
Vaccination and
the Vaccination
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**SMALLPOX DEATHS of PERSONS resident in each of the METROPOLITAN UNIONS in each of the YEARS 1871 and 1872,
distinguishing the DEATHS under FIVE YEARS of AGE.**

UNION.	Total Population in 1871.	Popula- tion in 1871 under five years of age.	1871.								1872.								Proportion per cent. of Smallpox Deaths under five years of age to Smallpox Deaths at all ages in 1871 and 1872.	Total Smallpox Deaths in 1871 and 1872 (com- bined) per 1,000,000 of population.	Smallpox Deaths under five years of age in 1871 and 1872 (com- bined) per 100,000 children living under that age.	UNION.	
			Smallpox Deaths at all ages.				Smallpox Deaths under five years of age.				Smallpox Deaths at all ages.				Smallpox Deaths under five years of age.								
			In Dis- trict.	In Asy- lum Hospi- tals.	In Small- pox Hospi- tal.	Total.	In Dis- trict.	In Asy- lum Hospi- tals.	In Small- pox Hospi- tal.	Total.	In Dis- trict.	In Asy- lum Hospi- tals.	In Smallpox Hospital.	Total.	In Dis- trict.	In Asy- lum Hospi- tals.	In Smallpox Hospital.	Total.					
Paddington - -	283,153	34,084	54	52	2	108	78	10	—	105	8	5	1	14	26	—	—	31	30.4	1,585	399	Paddington.	
Kensington - -			64	65	3	132		14	—		39	30	2	71		4	—					Kensington.	
Fulham - -			64	27	13	104		3	—		12	4	3	19		1	—					Fulham.	
Chelsea - -	71,089	8,631	64	58	8	130	31	7	—	38	26	17	2	45	11	1	—	12	28.6	2,462	579	Chelsea.	
St. George, Hanover Square.	155,936	15,725	354	89	8	451	170	20	—	190	12	12	—	24	1	1	—	2	40.0	3,046	1,231	St. George, Hanover Square.	
Westminster - -	51,181	5,220	27	27	3	57	10	5	—	15	6	4	1	11	3	2	—	5	29.4	1,329	383	Westminster.	
Marylebone - -	159,254	17,209	132	143	4	279	60	33	—	93	31	34	5	70	15	12	—	27	34.4	2,122	692	Marylebone.	
Hampstead - -	32,281	3,470	25	41	4	70	3	7	—	10	3	7	1	11	1	1	—	2	14.8	2,509	346	Hampstead.	
Pancras - -	221,465	28,355	450	269	43	762	210	43	—	253	58	33	7	98	30	3	—	33	33.2	3,883	1,009	Pancras.	
Islington - -	213,778	28,701	320	125	18	463	125	14	—	139	36	18	5	59	18	2	—	20	30.4	2,441	554	Islington.	
Hackney - -	124,951	16,134	303	104	1	408	125	17	—	142	96	32	—	128	52	2	—	54	30.8	4,290	1,215	Hackney.	
St. Giles - -	53,556	5,895	44	46	3	93	24	10	—	34	9	4	—	13	3	1	—	4	35.8	1,979	645	St. Giles.	
Strand - -	41,339	4,041	35	41	3	79	10	16	—	26	4	4	—	8	2	—	—	2	32.2	2,104	693	Strand.	
Holborn - -	163,491	21,033	209	158	3	370	70	31	—	101	38	41	—	79	20	9	—	29	28.9	2,746	613	Holborn.	
City of London - -	75,983	7,321	78	27	11	116	35	4	—	39	21	24	2	47	9	5	—	14	32.6	2,145	724	City of London.	
Shoreditch - -	127,164	18,236	442	127	1	570	221	26	—	247	32	14	2	48	15	—	—	15	41.8	4,860	1,414	Shoreditch.	
Bethnal Green - -	120,104	18,142	379	155	—	534	243	53	—	296	82	40	—	122	59	10	—	69	55.7	5,462	2,012	Bethnal Green.	
Whitechapel - -	76,573	9,677	159	65	1	225	89	8	—	97	18	15	—	33	11	2	—	13	42.6	3,369	1,137	Whitechapel.	
St. George - in - the East.	48,052	6,685	62	21	17	100	39	1	1	41	7	15	—	22	2	1	—	3	36	2,539	668	St. George-in-the East.	
Stepney - -	57,690	8,106	77	41	—	118	32	6	—	38	17	17	—	34	8	2	—	10	31.5	2,461	592	Stepney.	
Mile End Old Town - -	93,152	13,666	169	43	—	212	77	2	—	79	35	16	1	52	13	1	—	14	35.2	2,834	680	Mile End Old Town.	
Poplar - -	116,376	17,861	165	55	—	220	69	10	—	79	183	27	—	210	82	2	—	84	37.9	3,695	912	Poplar.	
St. Saviour's - -	175,049	23,922	457	186	1	644	233	35	—	268	65	33	—	98	49	5	—	54	43.4	4,239	1,346	St. Saviour's.	
St. Olave's - -	122,398	18,301	278	45	—	323	123	4	—	127	33	14	1	48	10	2	—	12	37.5	3,031	759	St. Olave's.	
Lambeth - -	208,342	28,367	319	190	1	510	132	22	—	154	96	58	—	154	44	3	—	47	30.3	3,138	708	Lambeth.	
Wandsworth - -	125,060	17,616	380	106	1	487	192	6	—	198	25	14	—	39	12	—	—	12	39.9	4,206	1,193	Wandsworth.	
Camberwell - -	111,306	15,720	153	58	—	211	66	4	—	70	42	28	—	70	22	1	—	23	33.0	2,524	591	Camberwell.	
Greenwich - -	100,600	13,963	71	31	—	102	38	3	—	41	38	23	1	62	20	1	—	21	37.8	1,630	444	Greenwich.	
Lewisham - -	51,557	6,437	10	13	2	25	3	1	—	4	7	5	1	13	2	1	—	3	18.4	737	109	Lewisham.	
Woolwich - -	73,380	10,110	39	10	—	49	21	—	—	21	47	14	—	61	20	1	—	21	38.2	1,499	415	Woolwich.	
Patients from extra- Metropolitan Unions sent to London Smallpox Hospital.	—	—	—	—	30	30	—	—	—	—	—	—	11	11	—	—	—	—	—	—	—	—	Patients from extra- Metropolitan Unions sent to London Smallpox Hospital.
Whole Metropolis -	3,254,260	422,629	5,383	2,418	181	7,982	2,529	415	1	2,945	1,126	602	46	1,774	560	76	—	636	36.7	2,970	847	Whole Metropolis.	

* * The numbers in this Table for the whole Metropolis do not exactly correspond with those in the Registrar General's Returns: (1) because in the Return from the Asylum District the deaths which occurred in the Hampstead Hospital in the last few weeks of 1870 are included, and could not easily be separated; and (2) because the Returns both from the Asylum District and from the London Smallpox Hospital are of deaths which occurred within each year, while the Registrar General's Returns are of deaths registered within the year. The smallpox deaths, therefore, in the Table for 1871 are somewhat in excess of those published by the Registrar General: those for 1872, a little below. The difference is quite immaterial for any conclusions; I simply note that there is a difference.

51 smallpox deaths under five years of age were registered in the years 1871 and 1872, was good enough to make at my request specific inquiries respecting them and ascertained that 17, or exactly one third, were in children born before the Act of 1867 came into operation.*

On Smallpox in its relation to Vaccination and the Vaccination Laws.

and to other unions.

As in the metropolis, so in England generally, there were but few unions in which there was not a diminution from the proportion which the deaths under five years of age had borne to the total mortality before the Act of 1867: but the difference was very marked between unions in which the execution of that Act had been defective, as in the unions of Sunderland, South Shields, Dudley, or Walsall, in all of which the proportion remained above 40 per cent., and unions in which it had been well administered, as in Manchester, where the proportion was only 25 per cent., or Leeds, where it was less than 19 per cent. In that part indeed of the union of Leeds which constitutes the *township*, and is the most thickly inhabited, but in which the Act of 1867 had, from the time it came into operation, been carried out by a most efficient Officer, with model care and exactitude, the proportion was but 17 per cent.†

The total smallpox deaths in England under five years of age were 7,770 in 1871, and 5,758 in 1872. The only European State from which we have the full information requisite for instituting a comparison with this mortality is Holland. The result is as follows:—

* Of the remaining 34 deaths, 12 were in children under three months old, and four in children who, though more than three months old when they died, had probably contracted the smallpox before attaining that age. Only 18 were in children who could be ascertained to have been born subject to the provisions of the Act, and of these 10 had been born in other places and migrated into the parish of St. Luke's. So that eight deaths of children under five years old, born in the parish and subject to the provisions of the Act, was the outcome of the two years' prevalence of this epidemic in the parish (population 54,069,) during which time it had been extremely fatal among elder children and adults. In the Parliamentary Return, relating to the mortality of England, 1851–60, St. Luke's had a higher smallpox death rate of children under five years of age than any other Metropolitan Union, with one exception. The contrast speaks for itself.

† And of these, little more than one half were in children born within the township. The facts are so important and so instructive as to deserve mention in detail. The total smallpox deaths in the township of Leeds in 1871 and 1872 were 229, of which 39 only (or 17 per cent. as stated in the text) were under five years of age. A detailed inquiry, made subsequently at my request, respecting these 39 deaths, showed that 18 of them (12 admitted to be unvaccinated, 2 respecting whom vaccination was asserted, but without certificate, and without any particulars which would allow the statement being verified, and 4 respecting whom no particulars could be ascertained,) were in children who had been born out of the township. Of the 21 who had been born within the township, 14 were children (all unvaccinated) not within the provisions of the Act, 12 of them not having arrived at the age at which vaccination can be compelled and 2 of them having been born before the Act came into operation. There thus remain only 7 deaths of children born within the township and subject to the provisions of the Act: of these, 2 were children whose births had not been registered, and whom therefore there had been no means of tracing; 3 were children whose vaccination had been postponed by medical certificate; 1 was a child said by its parents to have been vaccinated, but of whose vaccination there was no medical certificate; and there remained only a single case of a child medically certified as vaccinated. As the births of this district exceed 5,500 per annum, that is to say, as there were above 11,000 births during the period this severe epidemic lasted, the result not only reflects the highest credit on the officer, but illustrates in a remarkable manner the control which may be maintained over the smallpox mortality of the young by an efficient execution of the law.

On Smallpox in its relation to Vaccination and the Vaccination Laws.

The smallpox mortality under five years of age in England as compared with that of Holland,

Kingdom.	Population in 1871.	Actual Smallpox Deaths under five years of age in 1871 and 1872.	Smallpox Deaths under five years of age in the two years for equivalent populations of 1,000,000 of all ages.
England -	22,712,266	13,528	596
Holland -	3,632,237	9,356	2,548

and in the chief towns of England as compared with that of various towns abroad.

But for particular town populations we have the material for extending our comparison beyond Holland. The smallpox deaths under five years of age in London from the last quarter of 1870 to the end of 1872 inclusive were 3,842, a number which for the entire period is equal to 1,180 deaths per million of population at all ages. In the 17 unions of England which most nearly correspond to the 17 largest towns next after the metropolis, and which comprised at the census of 1871 a population of 2,446,353, there occurred 2,620 deaths under five years of age in the years 1871 and 1872, to which if we add 268, the number estimated as having occurred under that age (see footnote) in the same unions throughout 1873 and up to the end of the third quarter of 1874 inclusive, a total is attained of deaths resulting from the epidemic of 2,888, or exactly 1,180 per million of population at all ages.* The comparison with the chief towns of Scotland

* The following return is for the *unions*, not for the *towns*, of the respective names, of which towns in many instances the unions form but parts. The Registrar General was able readily to supply the deaths under five years of age for the former; it would have caused much trouble to supply them for the latter, and for the purposes of the comparison proposed, it was not at all necessary that that trouble should be incurred:—

Union.	Total Population in 1871.	Population under five years of age in 1871.	Smallpox Deaths at all ages in 1871 and 1872.	Smallpox Deaths under five years of age in 1871 and 1872.	Total Smallpox Deaths in the two years (combined) per 1,000,000 of population.	Smallpox Deaths under five years of age in the two years (combined) per 1,000,000 of population at all ages.	Smallpox Deaths under five years of age in the two years combined per 100,000 children living under that age.
Portsea Island -	113,595	14,817	549	133	4,837	1,171	895
Norwich -	80,386	9,919	563	142	7,004	1,766	1,437
Bristol -	62,662	7,397	83	23	1,323	367	311
Wolverhampton -	136,053	19,904	722	216	5,307	1,588	1,085
Birmingham -	231,015	31,901	310	70	1,341	303	225
Leicester -	95,220	12,953	321	111	3,371	1,166	857
Nottingham -	86,621	9,828	348	101	4,017	1,166	1,028
Liverpool -	238,411	28,497	831	346	3,444	1,451	1,414
Manchester -	251,956	33,298	321	81	1,234	321	243
Salford -	128,890	18,251	259	92	1,311	714	505
Oldham -	126,932	17,589	92	33	709	260	187
Bradford -	257,713	34,586	89	24	345	93	69
Leeds -	162,421	22,393	235	44	1,448	271	196
Sheffield -	162,271	24,256	874	426	5,385	2,625	1,760
Hull -	68,316	9,026	179	59	2,620	864	665
Sunderland -	112,643	16,746	1,005	432	8,922	3,870	2,609
Newcastle-on-Tyne -	131,198	18,642	835	287	6,357	2,187	1,539
Total -	2,446,353	330,033	7,626	2,620	3127	1071	790

In the above Unions there were 329 deaths from smallpox in 1873, and 473 in the first three quarters of 1874. If the proportion of deaths under five years of age were the same as in 1871 and 1872, 268 of these deaths would have been under five years of age, and 534 over the age of five years. A large number of these deaths in 1873 and 1874 ought not really to be included as part of the epidemic; they were mere casual cases in Unions in which there was nothing like an outbreak. But I have preferred to include the whole of them to prevent any evil being raised, as in the union which contributed the largest number (Birmingham) smallpox was really epidemic.

In the *Borough* of Birmingham, which besides the parish of Birmingham includes part of the union of Aston, the epidemic of smallpox during the present year (1874) has caused 639 deaths, or very nearly a third of the total smallpox mortality of England for that year—but yet a mortality, proportionately to population, very much below that of many of the large towns of England in 1871 and 1872. Of these 639 deaths, only 138, or 21·5 per cent., were in children under five years of age.

on the one hand, and the continental towns on the other, stands thus :—

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Places and Periods compared.	Amounts of Population.	Actual Smallpox Deaths under five years of age during whole period of the epidemic in each town or group of towns.	Smallpox Deaths under five years of age during whole period of the epidemic for equivalent population of 1,000,000 at all ages.
Chief towns of Scotland (1871-4) - -	1,083,750	750	692
London (1870-2) -	3,254,260	3,842	1,180
Seventeen Unions of England most nearly corresponding to the 17 chief towns (1871-4)	2,446,353	2,888	1,180
Berlin (1871-2) - -	882,569	2,837	3,448
Hamburgh (1871-2) -	338,974	1,938	5,717
Leipzig (1871) - -	106,925	659	6,200
Chief towns of Holland (1870-2) - -	693,080	4,474	6,455

The difference exhibited between the towns of Scotland and those of England is due partly to the fact that at the time of the outbreak the whole population of Scotland under 5 years of age was, as already explained, within the provisions of the Scotch Compulsory Vaccination Act of 1863, while only a part of that of England was within the provisions of the English Act of 1867 ; and partly to the imperfect way in which in some of the English unions the Act of 1867 had been carried out. Hence, in particular unions, the deaths under 5 years of age not only greatly exceeded the general rate above stated for the chief places of England, but even in a very few amounted to or exceeded the rate shown for Berlin. Sunderland, it will be seen, is the only union of those comprised in the Table in which the deaths under 5 years of age from the epidemic were, as compared with the total population, more numerous than those in Berlin. But there were one or two populous unions not comprised in the Table in which they exceeded even those of Sunderland, as Dudley, where they were at the rate of 3,952 per million, and South Shields, where they were at the rate of 4,136. Even these high rates of mortality, however, fell far short of those observed at Hamburgh or Leipzig, or in the chief towns of Holland, taken in the aggregate ; much less at some of these towns, as at Rotterdam, where the rate amounted to 9,045, and at the Hague, where it amounted to 10,437.

The deaths in London under five years of age, *as compared with the population living under that age* (422,629 by the census of 1871), were for the two years and a quarter the epidemic lasted 909 per hundred thousand ; in the 17 large unions comprised in the table they were for the two years specified therein 790 per hundred thousand, and if the subsequent deaths to the end of the third quarter of 1874 be added, 875 per hundred thousand. There were five of these unions, and five only,

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in which the death rate on this basis, for the full time the epidemic lasted in each, exceeded that of Dundee (1,140 per hundred thousand); viz., Liverpool (1,414), Norwich (1,437), Newcastle-on-Tyne (1,539), Sheffield (1,760), and Sunderland (2,609). None of them approached the rate exhibited by Berlin, much less that exhibited by Leipzig, the only continental towns for which I am able to make the comparison.

Though the comparison between the towns of England and Scotland is for the reasons already stated unfavourable to the former as regards the smallpox mortality of young children, it is not so as regards the deaths of persons who are older. And this is just what might have been anticipated from the fact that a compulsory vaccination law (though only one of moderate efficiency), was at work in England ten years before there was any such law in the other divisions of the United Kingdom. Taking the chief-town population of Scotland as estimated at the middle of 1872 at 1,094,061, and deducting the persons under five years of age, there remain 946,628 above that age, among whom there occurred in the $3\frac{1}{2}$ years 2,442 smallpox deaths, or at the rate of 2,580 per million. The smallpox deaths in London above five years of age were for the entire period the epidemic lasted 6,873, which on the population enumerated in 1871 above that age (2,831,631) gives a rate of 2,430 per million. In the 17 large extra-metropolitan unions most nearly corresponding to the chief towns, the smallpox deaths above five years were in the $3\frac{3}{4}$ years 4,543, which, on the population above that age enumerated in 1871 (2,116,320), gives a rate of 2,140 per million.

If I have not adverted to any influence which general sanitary conditions may have exercised on the smallpox mortality at home or abroad, it has been because the amount of any such influence is known to be wholly insignificant as compared with that of the presence or absence of effective vaccination in controlling smallpox mortality, especially in young children. What change of sanitary conditions, for instance, could have so reduced in a few years the proportionate smallpox deaths among young children, that in the chief towns of Scotland the deaths of children during the recent epidemic have been little more than a tenth of what they would have been according to the rate which prevailed before the compulsory vaccination law? The power of vaccination to save young children from fatal smallpox no matter what their sanitary conditions, and (with rare exceptions) notwithstanding extreme epidemic influence, is one of the best established facts in medical science. It was abundantly illustrated in medical practice in the recent as it has been in every preceding epidemic. And it is undoubtedly to the application of this great prophylactic measure to children at a sufficiently early age that the remarkable saving of life exhibited by the facts brought together in this section, is to be attributed.

Effect of com-
pulsory vacci-
nation in
England on
the general
smallpox death
rate,

The English Vaccination Act of 1853 had not been long in operation before its beneficial effects were demonstrated in a remarkable diminution of the general smallpox death rate of England, which soon began to compare favourably with the rates observed in those European States which were at that time regarded as relatively the best vaccinated. From the time when (in 1837) a national registration of the causes of deaths was commenced in England up to 1854 inclusive, the average annual smallpox death rate had been 405 per million of population, or more than double the average during those years of the death rate of Prussia—196 per million. But from 1855 onwards the difference began to diminish, till in 1859 the smallpox death rate of England fell below

as compared
with that of
Prussia,

that of Prussia, and so has continued in every subsequent year.* The average annual smallpox death rate of England from 1855 to 1870 inclusive was only 175 per million; that of Prussia during the same 16 years did not decline at all, nor did it even remain stationary at 196, but actually increased to 267: an increase which is extremely significant, and affords us a most valuable warning. For it was during those very years that an active propaganda against vaccination was at work in Prussia, and its influence not being counteracted by a compulsory law of direct and easy application (as already explained), the natural result occurred, and a remarkable falling off in the annual vaccinations took place.† It is not, therefore, in the least surprising to find that in the epidemic of 1871 the smallpox death rate of Prussia should have been so much higher than that of England.

The smallpox death rate of England up to 1854 (405 per million) was more than double the death rate of Sweden for the 45 years from 1810 to 1854 inclusive, (177 per million). But the average in England from 1855 to 1870 inclusive (175 per million) was not more than the previous general average of Sweden, and was in fact lower than the actual average of Sweden during those 16 years, such average having been raised for that period to an annual rate of 195 per million by a severe epidemic which occurred between 1865 and 1869. The earlier age at which, since 1853, vaccination has been performed in England than it is in

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and with that of Sweden.

* Annual smallpox mortality per million of living population in Prussia and in England from 1855 to 1871 inclusive:

—				Prussia.	England.
Average of the seventeen years 1838-1854				196	405
1855	-	-	-	90	136
1856	-	-	-	70	121
1857	-	-	-	130	206
1858	-	-	-	260	335
1859	-	-	-	200	197
1860	-	-	-	190	140
1861	-	-	-	300	66
1862	-	-	-	210	81
1863	-	-	-	340	293
1864	-	-	-	460	373
1865	-	-	-	440	309
1866	-	-	-	620	144
1867	-	-	-	430	118
1868	-	-	-	180	96
1869	-	-	-	190	72
1870	-	-	-	170	118
Average of the sixteen years 1855-70				267	175
1871	-	-	-	2,430	1,024

† See table at p. 119 of Dr. Guttstadt's report. In the six years which preceded the outbreak of 1871 the annual infantile vaccinations of Berlin had averaged only 45 per cent. of the births. In the period from 1840 to 1854 they had averaged 70 per cent. In Leipzig, where there was no counteracting law at all, there had been, from the like causes a similar diminution in the vaccinations annually performed. (Wunderlich, Archiv der Heilkunde, 1872.)

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Sweden has thus more than compensated for the length of time a compulsory law had been in operation in that kingdom in the effect produced on the general smallpox death rate of the two kingdoms. What will be the result of a comparison of them as affected by the recent epidemic cannot at present be stated, in consequence of the late period at which in Sweden the epidemic set in, and of its course there being as yet incomplete.*

§ 5.

Analysis of the
mortality of the
epidemic in
England at
different ages.

Of the 42,220 smallpox deaths which took place in England in 1871 and 1872, 5,817 (viz. 3,161 in 1871 and 2,656 in 1872) were in children under the age of one year. The proportion which this infantile smallpox mortality bears to the total smallpox mortality is somewhat less than 14 per cent., while previous to the Vaccination Act of 1867 the average annual proportion was, with scarcely any variation from year to year, 24 per cent. These 5,817 deaths include the cases (which constitute undoubtedly a large proportion of them) in which the disease was contracted before the children had attained the age when vaccination under penalty can be enforced—cases in which life might undoubtedly have been saved by timely vaccination, but to which it would be difficult to extend a compulsory law. The remainder, except of course those cases in which there had been lawful postponement of vaccination on account of the children's health, were the result of illegal postponement and neglect.

The deaths
under 15 years
of age were
nearly all
in the un-
vaccinated,

The deaths between the ages of one and five years were 7,711; between 5 and 10 years, 6,566; and between 10 and 15 years, 2,535, making an aggregate of 16,812 deaths between the ages of 1 and of 15 years. Of these all but a fraction might have been saved by efficient vaccination, and a very large proportion would undoubtedly have been saved if all the population up to 15 years of age, and not merely a very limited part of it, had been under the application of a vaccination law as effective as that which is now in force in England. Although in the vast majority of vaccinated persons the vaccination completely exhausts (usually for life and at all events for a great number of years) the susceptibility to variola, it is a knowledge which dates back to the earliest days of vaccination that there are some persons in whom that susceptibility is only partially exhausted and who may contract the smallpox within a few years, and even within a few months, or weeks, of having been vaccinated. Willan, writing in 1806, within eight years of the promulgation of vaccination, had himself already seen 30 such cases, and whenever the disease is extensively epidemic instances of this kind are not unfrequently met with. But the infection under these circumstances is usually so modified in its effects, the smallpox resulting is generally so mild and so void of danger to the individual attacked, that it is laid down as a rule by the leading medical authorities on this subject that in vaccinated persons under 15 years of age severe smallpox is rare, and deaths from that disease scarcely noticable.† Under intensity of

* The long delay (up to two years of age) which the law of Sweden allows for the vaccination of children renders a large infantile smallpox mortality inevitable whenever that disease becomes epidemic; but, besides this, there has been, as I am informed by Dr. Berlin, the President and Director-General of the Medical College at Stockholm, considerable laxity, in that city at all events, in carrying out the law. As England, under its imperfect law of 1853, is shown above to compare not unfavourably with Sweden, a still more favourable comparison may be expected under the Acts of 1867 and 1871. The partial returns received from Sweden (see ante § 3) justify so far this anticipation.

† Entries, not unfrequently met with in the death registers at times when smallpox is epidemic, of death from "smallpox after vaccination" in young children are

epidemic influence, when a malignant and hæmorrhagic form of the disease prevails, it stands to reason that severe cases in vaccinated persons, whether children or adults, will be more common and deaths more numerous than at other periods, just as the mortality of the natural disease then increases (see § 2), and just as persons who may have already had smallpox are then more liable to take it, and to have it severely, a second time. Especially where the vaccination had been at all imperfect, the imperfect cases would be picked out in larger proportion than usual. Accordingly, in the recent epidemic, the severity and malignancy of which has been very largely in excess of anything within our previous experience, the deaths of children under 15 years of age bearing some marks of vaccination appear to have been more numerous than in previous epidemics. But still they were exceptional, and when the vaccine marks were satisfactory the mortality was very trifling. Among 420 smallpox patients under 15 years of age with proper vaccination marks (irrespective of the number of such marks, which at this early age seems to be of comparatively much less consequence), who were treated in the Stockwell Smallpox and Homerton Fever Hospitals, there were but two deaths, the total smallpox deaths in these hospitals under that age being 179. Of the remaining 177, 12 were in children who had been vaccinated but whose marks were of a manifestly imperfect character, and 165 in children who had not been vaccinated at all.* It does not, I think, admit of reasonable doubt that the 16,812 smallpox deaths arising from the epidemic in England between the ages of 1 and 15 years were, with comparatively small exception, the result of sheer neglect of vaccination.

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The deaths in persons *above* 15 years of age which were registered in the two years were 19,591; of which 3,288 were between the age of 15 and 20 years and 16,303 had passed the age of 20. A very large proportion of these deaths, especially of those past 20 years of age,† were in persons who had been vaccinated. In the several hospitals of the Metropolitan Asylum District there occurred 1,358 deaths in persons above 20 years of age,‡ and of these 799, or about 60 per cent., were in persons who had been vaccinated and 559 in persons not vaccinated. These proportions, however, cannot safely be applied to the kingdom generally; for in the hospitals of some of the provincial towns the preponderance (though not a large one) of fatal adult cases was in the unvaccinated, and there is besides good ground for believing (as will be immediately stated) that the proportion of adults who are vaccinated is considerably larger in the metropolis than in the provinces. Still I think it may without hesitation be accepted that of the fatal cases of smallpox above 15 years of age, half, or thereabouts, were in persons who had been vaccinated, or who had at least undergone something which had passed for vaccination.

but those above 15 years of age about equal among the vaccinated and unvaccinated,

almost invariably incorrect and misleading; the cases in which the entry occurs being generally cases in which the vaccination had been performed while the patients were incubating the smallpox. Sometimes also cases are so entered in which an attempt at vaccination had been made, but without success.

* In the Poliklinik at Leipzig, of 117 cases of smallpox treated in vaccinated children under 15 years of age, none was fatal: of 266 cases treated in unvaccinated children under 15 years of age, 110 died (Thomas, *Archiv de Heilkunde*, 1872).

† Eighteen is, according to Mr. Marson, the age at which post-vaccinal smallpox begins to be chiefly noticeable.

‡ The deaths which occurred in these hospitals between 15 and 20 years of age cannot be given, as in the Table in the Report of the Asylum Boards Committee the cases, after the age of 10 years, are arranged in decennial periods of age only. Between 10 and 20 years of age the majority of deaths was in the unvaccinated.

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the number of persons vaccinated being probably at least 50 to 60 times as many as the unvaccinated;

showing the great protection which even in them vaccination had afforded.

Deaths so far as they occurred in the vaccinated were due mainly to imperfect vaccination.

Mr. Marson's observations.

But if the *actual number* of smallpox deaths in persons above puberty who had been vaccinated were equal to, or even exceeded, that which occurred in persons who had not been vaccinated, it must be borne in mind that the proportion of our adult population which is protected against smallpox by vaccination is at least from 25 to 30 times as great, and much more probably from 50 to 60 times or more as great, as that which is unvaccinated. The *relative* number of persons who now-a-days attain manhood or womanhood without having been vaccinated is very small. Examination of the young men who are recruited for the Army has shown for many years past that, putting aside the small percentage who are marked with smallpox, the proportion of the remainder who do not present distinct marks of having undergone vaccination averages for the whole of England 3·9 per cent. of those examined, and for London separately 2·8 per cent.* As these small proportions include all doubtful cases, it is clear then that somewhat considerably more than 96 per cent. of those in England, or than 97 per cent. of those in London only, must have been vaccinated. Now recruits, I apprehend, are not generally drawn from that class of the population which has been the most cared for; and there is, therefore, a reasonable probability that the proportion of the whole adult population of England which is thus protected against smallpox is much larger. But even if the full proportion just given, or more than that proportion, be applied to the adult population generally—4 per cent. being taken as unvaccinated, and 96 per cent. as vaccinated—it is clear that, with equal *actual* mortality among the two classes, the *relative* mortality of the former would be 24 times that of the latter. The figures then are conclusive that vaccination *as it was practised in this country 15 years ago and upwards*, instead of failing to protect persons from fatal smallpox after they had grown up, has in the immense majority of cases very effectually protected them. It would be a waste of time to insist on this any further. Much more important is it to consider how it is that it did not protect in the remainder, and that in two years (two years it is true of intense epidemic influence) an enormous number of adults, probably from 9,000 to 10,000, who in a rough and general sense must be taken as vaccinated, should have perished of smallpox in England.

The answer is not difficult—though it is not one which can be given with any satisfaction. The cases were, it may be affirmed with the utmost confidence, with comparatively few exceptions, cases in which the vaccination had not been thoroughly and efficiently performed. At the time this recent epidemic set in, rather more than 17 years had elapsed since Mr. Marson, in a memorable communication to the Royal Medical and Chirurgical Society of London, founded on his (even then unequalled) experience of smallpox at the London Smallpox Hospital, called attention to the fact that the fatal smallpox which during 16 years' observation he had met with in that Hospital, in persons in whom vaccination was said to have been performed, had been almost entirely in cases in which the vaccination had been imperfect, the vaccine marks being either wanting in essential characteristics, or deficient in number, or both. He demonstrated that, apart from any question of the

* Average of six years terminating in 1871. The Army Medical Report for 1872, which has appeared since this average was cast, shows that of all the recruits examined in England during that year, putting aside the few who had marks of smallpox, there were only $2\frac{1}{2}$ per cent. (2·6) without marks of vaccination, and of those examined in London—upwards of 4,000 in number—only a little more than one per cent. (1·05). I have thought it right to make my assumptions in the text as unfavourable as possible to vaccination. I do not myself suppose that even one per cent. of the *general* adult population is unprotected.

different relative liability of well and ill vaccinated persons *to contract* smallpox, any vaccinated persons who *did* take it had it lightly or severely, with scarce any risk of death or with a risk not inconsiderable, according to the quality of the vaccination they had received. To the cases which he had at that time collected and analysed, and from which he drew these conclusions, he has since been able to add the result of 16 years' further experience (up to 1867) on patients who, though admitted to the hospital since the publication of his paper, had with very few exceptions been vaccinated prior to that time.* Taking the two series of observations together, an analysis of 1,161 smallpox deaths which had occurred in that Hospital in persons stated to have been vaccinated shows that in 614, or more than one-half of them, the vaccination had been little else than nominal, for in no fewer than 180 no mark whatever of successful vaccination could be discovered, and in 434 only a single mark of imperfect character. Of the remaining 547 deaths, 513 were in cases which, either in the character or in the number of vaccine marks which each presented, or in both these respects, fell considerably short of the standard of good vaccination, for in 384 the character of the vaccine marks was imperfect, and in 129 though the marks were characteristic they were only one or two in number. There had been in the Hospital but 34 deaths altogether in persons who had three or more proper vaccine marks, though 2,584 patients having such marks had been admitted; and in 18, or more than one half of these 34 deaths, the fatal result was not due to the smallpox merely (which in some of them was slight), but either to its being complicated with some other disease from which the patient was suffering, or to the patient having contracted some other disease, as erysipelas, &c., in the Hospital. Of the 2,584 patients to whom reference has just been made as having been admitted with three or more good vaccine marks, 1,505 only had the four or more such marks which constitute *the standard* of good vaccination, and among these 1,505, the fatal cases had been 13 only, in 10 of which there had been superadded disease. Summarily, the 32 years' observations show that, of 13,765 reputedly vaccinated patients admitted to the Hospital during that period the vaccination was very defective in 11,172, of whom 1,027 died; was reasonably good (as represented by three characteristic marks) in 1,079, of whom 21 died; and was quite up to the now acknowledged standard in 1,505, of whom only 13 died. These facts, while they are conclusive as to the necessity for vaccination, if it is to be a complete or nearly complete protection against fatal smallpox, being performed in the most thorough and careful way, illustrate also the extent to which imperfect and insufficient vaccination was practised at the period when the present adult vaccinated population, the recent smallpox mortality amongst whom is now under our consideration, would have received their vaccination.

The records of the various Hospitals in which smallpox was treated during the recent epidemic agree in showing, as has been already stated (§ 2), that the proportion of deaths to attacks among the vaccinated taken generally was, compared with those among the unvaccinated, very small; the proportion however in both classes being so influenced by the intensity and malignancy of the epidemic as to be considerably above the usual average. Unfortunately, most of these reports merely distinguish between the "vaccinated" and the "unvaccinated," and take no note of the quality of the vaccination. Wherever this was done Mr. Marson's observations were found substantially to hold good, nearly

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in the several
London and
provincial
Hospitals.

* Evidence as given in Report of Select Committee on Vaccination Act (1867), p. 236.

all the fatal cases being amongst such as had been ill vaccinated or insufficiently vaccinated, and the deaths amongst persons thoroughly vaccinated being in comparison strikingly few. Some careful observations made in the Stockwell Smallpox and Homerton Fever Hospitals show that of 2,382 patients having marks of vaccination, 1,866 had characteristic marks (one or more), and 516 had marks which were bad or indifferent. Of the former 70 died, or 3·9 per cent.: of the latter 129, or 25 per cent. Of the 1,866 patients with characteristic vaccine marks, 1,306 had but one or two such marks, of whom 60, or 4·5 per cent., died; 560 had three or more such marks of whom only 10, or 1·8 per cent. died. According to the rate deducible from Mr. Marson's observations on patients with three or more good cicatrices of vaccination, the deaths among these 560 should not have been 10, but a little over 7; and probably the difference indicates what was due to exceptional epidemic influence. In the Leeds Hospital the deaths among the patients whose marks of vaccination were noted as imperfect were above 12 per cent., but among the patients with characteristic marks 2·75 per cent. only; there were 48 cases treated having three or more characteristic marks, but none of them was fatal. In the City of Glasgow Fever Hospital the mortality of the smallpox cases among the vaccinated with bad marks was 21 per cent., but of those with characteristic marks only 3·8 per cent; very few cases were admitted, and none died, having more than two characteristic marks. By some of the hospital physicians severe observations are made as to the "badness" of the marks in many of the cases so classified, these being so imperfect and so wanting in the essential characters of the vaccine mark that they might have arisen just as well from some other cause, and at all events showed the vaccine effect to have been next to nil. In two of the Smallpox Hospitals of the Metropolitan Asylum Board, observations made in 4,523 cases, having some marks of vaccination, with reference to the *number* of marks only and without any regard to their *character*, (an omission greatly to be regretted), showed a mortality of 15·2 per cent. in the cases with only one mark, 11·7 per cent. in the cases with only two marks, 9·4 per cent. in the cases with three, and 6 per cent. in the cases with four or more marks. The death-rate in these Hospitals among the unvaccinated was 55·9 per cent. Of a total of 506 deaths occurring in the 4,523 patients with marks of vaccination, 373 were in 2,846 persons having only one or two such marks, 88 in 936 persons with three, and 45 in 741 persons with four or more. The proportion of cases to deaths, whether among the entire number of patients with three or more cicatrices (133 deaths out of 1,677 cases,) or whether among that portion only who had four or more marks (45 deaths out of 741 cases), is about three times as great as that shown by Mr. Marson's observations on patients treated by him in the London Smallpox Hospital who had the same number of marks respectively, the good and bad marks being taken together, and cases of superadded disease not being deducted. Making every allowance for increase in the rate of mortality due to the malignancy of the epidemic, the proportion observed in the two hospitals of the Metropolitan Asylum Board is suggestive of an unusual amount either of superadded disease, or of hospital influence, or of vaccination of a very imperfect character, or of all these causes taken together. A valuable report made by Mr. Dyke, the Medical Officer of Health of Merthyr Tydfil, on the epidemic as it affected the district of his local board in 1871-2, in which he gives the result of inquiries made as to vaccination in *every case* of smallpox, fatal or not, known to have occurred within the district, shows that among 308 fatal cases which occurred there were but 30 in persons having three or more marks of

vaccination, though 1,070 cases having this number of marks came under observation; and that of these 30 six only were among that portion of the cases (418 in number) which had four or more vaccine cicatrices. The death-rate among the patients with one cicatrix was 8·5 per cent.; of those with two cicatrices, 6 per cent.; of those with three, 3·7 per cent.; and of those with four, 1·5 per cent.; of 22 patients who had more than four marks none died. The death-rate among the unvaccinated was 51·1 per cent.

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Whether, then, the smallpox deaths among the vaccinated adults in England, in the epidemic years 1871 and 1872 amounted to, or whether they exceeded, the 5,000 per annum at which I have ventured approximately to calculate them, this much appears to be very certain that, excepting a comparatively very small number of them, they were deaths which need not have occurred and would not have occurred had the vaccination been done, or had it taken effect, in the way and to the extent which experience has shown to be necessary for securing the *full* protective powers of vaccination. I say had it been done, *or had it taken effect*, for it must of course be allowed that there are cases in which, with the best performance of vaccination, the result may fall short of what was aimed at,—especially when, as must sometimes be the case, preserved lymph has to be used for vaccinating. But these are exceptions: and substantially the mortality was the mere outcome of the “carelessness and want of arrangements” with regard to vaccination, and the consequent “great deal of very inefficient, almost useless, vaccination performed in England,” referred to by Marson in 1856 in his petition to the House of Commons;* and of “the appreciable amount of “utterly incompetent vaccination” and “very considerable amount of second-rate vaccination” stated by Mr. Simon in 1857 to be at that time current (along of course with a large amount of thoroughly good vaccination) in England and Wales.†

The specific defects in the practice of vaccination which have led to these results were pointed out at the time by these eminent authorities, and the extent to which they existed in England was shortly afterwards brought out with great precision and detail in an inquiry officially made (1860–4) under direction of the Lords of Her Majesty’s Council by Medical Inspectors who visited every vaccination district in the kingdom. Summarily they were these: (1) a not inconsiderable amount of performance of vaccination by unprofessional and utterly incompetent persons; (2) a frequent want of special knowledge of vaccination on the part even of professional men, evidence of such knowledge not being a requirement of any of the licensing medical authorities; (3) a consequent disregard by such vaccinators, and even frequently a complete ignorance, of the rules laid down by Jenner as essential for the efficient performance of vaccination, and of the further rule emphatically laid down by the National Vaccine Board to be careful, in vaccinating, thoroughly to infect the system by the production of at least four vaccine vesicles‡—the disregard of the latter rule being in fact carried to such an extent

Causes of imperfect vaccination.

* Reprinted in “Papers relating to the History and Practice of Vaccination,” page 25.

† See Letter addressed to the then President of the Board of Health prefixed to the other official “Papers relating to the History and Practice of Vaccination.”

‡ The National Vaccine Board in their report for 1820 state that the principle of the practice they adopt and inculcate is “to affect the constitution of each individual very completely with the vaccine disease”; and, adverting to their directions to their own Vaccinators to make in each case four insertions of lymph, they add “from extensive experience and numerous reports, the Board have become most earnestly desirous that more, rather than fewer, vesicles should be produced.”

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that it was only by a minority of vaccinators that the rule had been observed : (4) a want of proper inspection by the vaccinators of the course and results of their operations. To these had to be added, as of enormous influence, the entire want of systematic arrangements for the proper performance even of public vaccination, so that instead of vaccination being done, as it ought always where practicable to be done, by direct transference of the vaccine lymph from arm to arm under conditions which should afford the vaccinator proper opportunity for selecting the lymph to be employed, it was extensively, and indeed most usually, done by employment of dry and otherwise preserved lymph with an inevitable large relative amount of failure.

The influence which Mr. Marson's important observations were calculated to bear on the practice of individual vaccinators—public or private—was very slow in manifesting itself. Although the Official Inquiry just referred to did not commence till nearly seven years after his paper had been communicated to the Royal Medical and Chirurgical Society, it was found that the great majority of vaccinators were still content with endeavours to produce sometimes one, more frequently two, and at the utmost three, vaccine vesicles. Practitioners who had vaccinated in this way all their lives, especially if in their own (very limited) experience they might not have chanced to see any fatal small-pox in persons whom they had so vaccinated, "couldn't see why" they should change their practice, nor "why" one vesicle shouldn't be as good as a dozen: and others who were willing to make a change had *their* troubles sometimes in the prejudices of parents, who, having been in the habit of seeing one or two insertions of lymph only made on children's arms, could not for their parts "see why" the doctor should be introducing new-fangled ways.

Steps which
have been taken
to remedy it in
regard to
public vacci-
nation.

The Acts which were in force relative to Vaccination at the time Mr. Marson's observations were published did not provide for the special qualification even of public vaccinators, nor control in any way the practice, even by the public vaccinators, of vaccination. While the Vaccinators of the National Vaccine Establishment had, from the foundation of the Establishment, been bound to the observance of very precise instructions in the performance of their vaccinations, the public vaccinators appointed under the Vaccination Acts had been left to do them each as he liked. It was not until 1858, that, under the Public Health Act of that year, power was given to the Privy Council to make Regulations for securing the *special* qualification of public vaccinators, and the efficient performance of public vaccination. In 1859 Regulations for these purposes were issued, which embodied "Instructions" to be observed by public vaccinators in the performance of their vaccinations. And in the same year a memorandum of advice was drawn up by the Medical Officer of the Privy Council for the guidance of the authorities who were charged with the local administration of public vaccination, explaining the principles on which their arrangements for public vaccination should be framed, with a view to the maintenance of a proper lymph supply, and to the performance of the operation in the most effective way, within their respective jurisdictions. The Regulations which were issued, so far as they affected the qualification of public vaccinators, took full effect from the first; but the alterations in practice which the Instructions required of the vaccinators were only made very gradually. By many, indeed, of those officers they were made at once cordially and with conviction; by others, merely out of a spirit of deference, and sometimes with openly expressed doubts as to their necessity; by very many they were not made at all. There were, as I have explained, prejudices to be got over.

The general result was that, though in a few years a very considerable improvement had been made, and was in progress, it was not at a pace which could be considered as satisfactory, nor such as the public safety required, and further measures for this purpose were therefore needed. In the equally important matter of arrangements for public vaccination, though certain minor changes had been effected, the radical alterations required were such as it was found could scarcely be carried fully out without such an amendment of the law as would bring them under the direct control of the central authority. These objects amongst others were sought to be accomplished by the "Vaccination Act, 1867."

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Under that Act an entire reconstruction of the public vaccination arrangements of the kingdom, founded on the principles above stated, has been gradually going on and is now all but completely effected; skilled systematic supervision of the public vaccinators is provided for; and the fees to public vaccinators, which continue to be paid to them out of local funds on their own report of the success of their several operations, are supplemented by further payments out of monies voted by Parliament to those vaccinators, and to those vaccinators only, by whom the Reports of the Government Inspectors show that certain prescribed conditions, including of course a complete observance of the Regulations and Instructions in force for public vaccinators, have been fulfilled, and that the results attained in regard to the quality of vaccination have been altogether satisfactory. The improvement which has thus in a few years been effected in the character and completeness of the vaccination performed is, as shown by the Inspectors' reports, quite remarkable. So far as the public vaccination of the kingdom is concerned, there can, I think, be no doubt that it is now being performed, generally, under arrangements the most conducive to success, and with a careful observance of the instructions laid down; and that, as the result, the children so vaccinated are receiving a full measure of protection against smallpox, instead of the limited measure which used to be accorded them. A large number of children, however, it must be remembered, are annually vaccinated by private practitioners over whose proceedings there is no control.*

* It is disagreeable to speak, but I feel it a duty to do so, of the very imperfect way in which to my own knowledge private vaccination is not unfrequently done. Especially it has been brought to my notice on several occasions that, in certain districts in which medical competition of a low character is carried on, there are practitioners who bribe (as it were) parents not to attend the public vaccination stations by the offer to vaccinate the children imperfectly, *i.e.*, in one or two places only. In the report of the Leeds Smallpox Hospital for 1872 I find the following comments, in which I entirely agree: "It is much to be regretted that while Government takes care that vaccination inspectors are appointed to every district, and the strictest supervision maintained over public vaccinators, there is no inspection whatever of the children who are vaccinated at private surgeries or at their own homes, the production of a formal certificate being considered a sufficient guarantee that the operation has been properly performed." Another very serious drawback to private vaccination is that it is so often done with preserved lymph (in tubes or on points), and that consequently it so often either partially or wholly fails. An illustration of this disadvantage is afforded in the Vaccination Officers' Returns for 1872, published in this volume. It will be seen, on reference to these Returns, that no fewer than 354 of the children born in the metropolis in that year were certified as legally "insusceptible of vaccination," in other words, as having been three times vaccinated unsuccessfully. Now I think I can undertake to say that there was scarcely an occurrence of this kind at any of the public vaccination stations in London in 1872, or any subsequent year; and I do not doubt that if any of these children were taken to a public station and there vaccinated they might obtain the protection against smallpox which unfortunately they are now without. *Real* insusceptibility to vaccination, it is well known, hardly exists.

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It will be years to come before the persistent power of vaccination as practised within the last six or seven years to protect from smallpox, and especially from severe and fatal smallpox, will be tested, for it is seldom before puberty, and generally not till after 18 years of age, that serious post-vaccinal smallpox occurs. We are only in fact now approaching the period, when even the earliest measures which were taken for the improvement of the quality of vaccination in England can be tested on any portion of our adult population.

§ 6.

Re-vaccination.

The observations which were made during the recent epidemic afforded remarkable evidence of the value of re-vaccination, not merely in controlling the mortality from smallpox, but usually in preventing altogether the occurrence of the disease. Its power of preventing smallpox under circumstances the most favourable of all others for contracting it was tested on a very large scale on the nurses, servants, and attendants of the various Hospitals established for the treatment of the epidemic in the metropolis and in the provinces: the attendants in the Hospitals of the Metropolitan Asylum District alone amounting at one time to above 300. In every hospital report which has reached me it is specially stated that not a single one of these officials, who had been re-vaccinated before coming to take duty at the hospital, contracted smallpox. On the other hand, a few cases of the disease occurred in some nurses and servants in the Hospitals of the Metropolitan Asylum District whose re-vaccination in the pressure of the epidemic had been overlooked, and there was one case in a nurse who, having had smallpox previously, had consequently not been vaccinated on coming to the Hospital. There was also a very modified case in a nurse in whom re-vaccination had been performed, but not till after her arrival at the Hospital, and when the smallpox infection had already been received. The cases of smallpox which were admitted for treatment in the several Hospitals in persons who had been successfully re-vaccinated were very few and very slight. In the Hospitals of the Metropolitan Asylum Board, in which upwards of 14,800 cases of smallpox were treated, there were but four cases in which there was good evidence of re-vaccination having been performed with effect, and these were all light cases. In Liverpool, says Dr. Trench,* re-vaccination was found a constant and perfect protection against the smallpox. In the Newcastle-on-Tyne Smallpox Hospital, in which 778 cases were treated, there were two in which re-vaccination was alleged to have been successfully performed (but without mention whether there were marks of such re-vaccination or not), one of them 10 years and the other four years before the attack of smallpox: both recovered. In the same Hospital eight patients were admitted stated to have had smallpox before, five of whom were distinctly marked by it; one of the three not marked died, the remaining seven all recovered. In the Leeds Hospital there were four cases in which previous re-vaccination was alleged; but in none of them was the evidence of re-vaccination conclusive. One of them, in which the re-vaccination was said to have been done at seven years of age, was fatal; the other three cases were mild. There were three (fatal) cases of smallpox in persons believed to have had smallpox previously; but the evidence of the former smallpox is not stated. Similar infrequency and mildness of smallpox after re-vaccination was noted in the Hospitals abroad. In the Municipal Smallpox Hospital at Berlin, in which 1,529 cases were treated in persons who had been vaccinated, only 19 of these were in

* Annual Report of the Medical Officer of Health for Liverpool for 1871.

persons (all above 30 years old) who had been successfully re-vaccinated ; they were all of them cases of varioloid or of variolous fever without eruption, and none of them died. In the same Hospital there were seven cases (three of them fatal) in persons who had previously had smallpox.* In the Baracken-Lazareth, used also as smallpox Hospitals in the same city, in which 1,805 cases were treated in persons who had been vaccinated, seven only were in persons who had been successfully re-vaccinated, of whom six had a mild attack, and one (a woman 60-70 years old) had the hæmorrhagic form and died.† In the Hospital at Leipzig, out of 1,504 vaccinated patients there were 13 who had been successfully re-vaccinated in early life, all of whom recovered : in the same Hospital there were 22 cases in persons who had had previous smallpox, and of these six died.‡ In the Hospital at Hamburgh the cases in persons who had been re-vaccinated were more numerous, amounting to 59 out of a total of 2,267 vaccinated patients ; and there were three deaths.§

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§ 7.

The success, which has attended the Compulsory Vaccination Laws of the United Kingdom in reducing the smallpox mortality has certainly been very remarkable,—imperfect as the earliest law (for England) was, and short comparatively as is the time that, in either division of the Kingdom, and especially in England, laws of a more efficient character have been in operation. The smallpox deaths in young children (up to the age of five years), which previous to the system of compulsory vaccination constituted three quarters of all the smallpox mortality of the United Kingdom, constituted in 1871-2 less than a third of that mortality in England,|| and not so much as a fourth of that in Scotland or in Ireland. In consequence of the saving of life thus effected among the young the present average annual smallpox death-rate of the United Kingdom, as compared with the average rate of the period of optional vaccination, exhibits a remarkable diminution.

Resumé of the effects of the vaccination laws in saving of life from smallpox in United Kingdom.

The average smallpox death-rate of England for the 19 years from 1855 to 1873, inclusive, has, notwithstanding the extreme, and in our time unprecedented, malignancy of the epidemic we have recently gone through, amounted only to 250 per million of the population, as compared with 405 per million from 1838 to 1854 inclusive. In Ireland the diminution has been still more remarkable, the average death-rate for the ten years from 1864 to 1873 inclusive having been only 108 per million, as compared with an average of unknown amount, but which must at least have considerably exceeded 365 per million, from 1842 to 1860 inclusive. And though there are not yet the means for giving an average smallpox death-rate for Scotland since the introduction of compulsory vaccination which shall include the recent epidemic, sufficient is known to make it quite certain that that death-rate will be much below the previous average. In like manner, the smallpox death-rates of the several divisions of the United Kingdom, which before the enactment of Compulsory Vaccination Laws had been in most unfavourable contrast with those of some Continental States, such as Prussia and Sweden, in which a system (though an imperfect one) of compulsory

* Report by Dr. Lothar Mayer, Deutsche Klinik, 1872, pp. 262 and 273.

† Report by Dr. Guttstadt, *ibid.*, p. 357.

‡ Report by Dr. Wunderlich, Archiv der Heilkunde, 1872, p. 97.

§ Report by Dr. Oppert, Deutsche Klinik, 1872, p. 72.

|| By the latest return—that for 1872—it constituted 30 per cent ; but now (in 1874), the Act of 1871 having been two years longer in operation, there is every reason to believe that a further reduction will have taken place, and that the proportion will be about the same as in the other divisions of the United Kingdom.

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Severe test afforded by recent epidemic of smallpox.

Opinion of the Vaccination Committee of the House of Commons.

Natural smallpox is as destructive as ever ;

and has the same tendency as ever to recur in epidemics.

Other epidemics are therefore to be expected.

Review of the securities against such outbreaks :

(1) in regard to enforcement of vaccination of infants ;

vaccination had for a long time been in force, are found now to compare most favourably with them.

An epidemic of smallpox so intense as that which recently prevailed, has afforded a very severe test of the value of our present vaccination laws : and when the mortality of that epidemic in Great Britain and Ireland is analysed and compared with its mortality in the other European States, for which the materials for such comparison have been supplied, it is impossible not to see that these laws have been the means of effecting an enormous saving of life among the young, and that such saving would have been much greater than it actually was, had they been sufficiently long in operation to bring within their scope all the children in the kingdom, (understanding by children all under puberty, say up to the age of 15 years,) and not merely a limited portion of them.

The facts of that comparison, and indeed the whole facts of the epidemic when carefully studied, afford the most complete confirmation of the opinion which was expressed (in 1871) by the Select Committee of the House of Commons on Vaccination that "On the one hand, if vaccination " had not been general, this epidemic might have become a pestilence as " destructive as smallpox has often been where the population has been " unprotected ; and that, on the other hand, if this prevention had been " universal, the epidemic could not have approached its present extent."

The epidemic may have been useful in reminding some, although no one who had practical knowledge of smallpox could ever have doubted, that that disease, uncontrolled by vaccination, is at the present day exactly the same disfiguring and fatal disease which in the last century destroyed, on an average, 3,000 persons annually out of every 'million of our population, and which, at that rate, would now, but for vaccination, be causing in England alone an average annual mortality of nearly 70,000. There is good ground, indeed, for believing that the present annual death-rate from smallpox would have exceeded that of last century ; for while the disease has lost nothing of its deadly character, the facilities of communicating it are infinitely greater now than they were formerly, on account of the constantly increasing aggregation of population in towns and cities, and the enormously extended means of inter-communication between place and place. The disease tends, just as ever, to recur in epidemics, and by and bye another epidemic will have to be faced, which may or may not have the character of ordinary epidemics of the disease, or may or may not be as virulent as that which has passed away, but against the fatality of which, however intense, we shall be able it is trusted to present much greater securities than were in existence at the time the recent outbreak took place, though not as yet all the securities we desire, or hope to attain.

In view of this contingency, which may surely be looked for, I would venture, in concluding this report, to make one or two observations on our present position in reference to these securities in England.

1. The first and most important of them is the vaccination of children in early infancy,—*pari passu* with the births. This is now, under the Vaccination Act, 1871, being accomplished in England to an extent to which it was never accomplished before ; as years pass on, a larger and larger proportion of the young population is being brought under protection ; and, by and bye, the whole of them (with some slight inevitable exception) will, we may fairly expect, be made safe against smallpox. The completeness of this result must, however, depend on the carefulness with which the systematic inquiries founded on the birth-registers into the vaccination of children, as directed by the Act, are maintained ; and any neglect in this respect on the part of any local authorities or local officers is an injury to the whole com-

munity. For obviously the consequences of such neglect cannot be limited to the localities in which the neglect occurs. The returns made by the vaccination officers concerning the births in England in 1872, which are tabulated in Appendix No. 1 to the present Report of the Medical Officer of the Board, show that all of these births but 5 per cent. were at the date up to which the returns were made (January 31st 1874) accounted for on the vaccination registers: a result which, under the circumstances explained in the memorandum attached to the returns, must, it appears to me, be regarded as highly satisfactory, and which would have been still more complete than it is but for some large deficiencies existing in a comparatively few unions, due almost entirely either to insufficient appointment of officers by the local authorities, or to neglect or incapacity on the part of the officers appointed. Such deficiencies, when they occur, require of course, and receive, the vigilant attention of the Local Government Board. It must at the same time be borne in mind that however careful the working of the laws may be, the migratory habits of the lower classes of the population and other causes must always render it impossible but that some children should escape observation. It is doubtful, I think, whether even in a kingdom like Scotland this proportion can ever be much less than the 2·2 per cent. of the births which has been the average proportion for the last four years there; and in England, with its enormous town populations, a larger proportion must necessarily be looked for. Hence the great importance of that excellent provision in the present vaccination law of England which makes it the duty of each vaccination officer not merely to look after the vaccination of the children born within his district, but also of those who have migrated to it.

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When these duties of foresight have been carefully executed, even for a few years, the dealing with importations of smallpox into any locality has been found to be a matter of comparative ease, consisting mainly in the exercise of great vigilance with regard to the surroundings of each imported case. Again and again during the recent epidemic did instances come to my knowledge where the smallpox was thus arrested or controlled; and one I will cite because it relates to a place—the city of Exeter—in which, before the Vaccination Act of 1867 came into operation, vaccination had been greatly neglected, and which had in consequence suffered very severely in previous epidemics of smallpox. On an official inquiry into the state of vaccination in that city, which I made in 1861, I found as many as 158 out of 844 children in attendance at the public schools unvaccinated. Exeter had a very fatal epidemic of smallpox in 1859, a slighter one in 1861, and again a very severe one in 1864 and 1865. When the Vaccination Act, 1867, came into effect steps were at once taken which have led to the complete vaccination of all children born subsequently in the city, and of as many as could be found of children who had been born in the city previously, or who have migrated into it. On the extension, in 1871, of the recent epidemic into the west of England, it soon found its way to Exeter. An incessant look-out for each imported case was kept by the vaccination officer, and in every such case, whatever measures in the way of vaccination or re-vaccination were required for the protection of the immediately surrounding population were at once taken. The result was that, though smallpox was imported many times into the city, and on certain occasions spread to a limited extent among adults and children born before the Act of 1867 who could not be got hold of in time, the total deaths caused by it were only one in 1871, eight in 1872, and 11 in 1873. Having an opportunity of inquiring with regard to nine of the 11 deaths of 1873, I found that the whole of these were either in persons grown up or in children born before 1868, with the single

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(2) in regard to the manner in which vaccination has been performed

(3) in regard to re-vaccination.

exception of a child aged $2\frac{1}{2}$ years not born in Exeter. Now, I believe that what was done here might be done under similar circumstances with the like results in every other place, and that in any and every locality where the current vaccinations are duly cared for, any outbreak of smallpox may be brought speedily and easily in like manner under control. But if the duties of foresight have been omitted, and if accumulations of unvaccinated children have been allowed to take place, any such dealing with an outbreak, at least in a crowded city, becomes almost impracticable.

2. The second, and scarcely less important, security is the performance of the vaccination always in the most complete and effective way. It is beyond doubt that, for want of this having been done, some thousands of persons died of the recent epidemic who had believed themselves secure. And I fear that unless re-vaccination be adopted by our present adult population, and by our present adolescent population when they are grown up, to a much larger extent than has been done, there must in the next, and in succeeding epidemics of smallpox for some time to come, be a not inconsiderable amount of adult mortality. For (1) though, under the improvements which have been described as having been effected in the performance of public vaccination, the proportion of thoroughly vaccinated as compared with imperfectly vaccinated children must be year by year largely increasing, a long while must elapse before the result of this will be fully visible on the smallpox mortality, inasmuch as it is not, as a rule, till after puberty that smallpox mortality even in the imperfectly vaccinated is met with; and (2) it must be recollected that the manner of performing vaccination is only within the control of the government so far as *public* vaccination is concerned.

3. The most perfect infantine vaccination is not an *absolute* eventual security against fatal smallpox, any more than the having passed through an attack of smallpox is an *absolute* security; but after proper infantine vaccination death from smallpox is very rare. Many persons, however, who have been properly vaccinated in infancy may at times of epidemic prevalence of smallpox contract the disease, and though they would have it generally in a very modified way, and with little or no risk of life to themselves, they would, from their liability to spread the infection, be of danger to the community, and so far even as themselves only are concerned would of course prefer not to have the disease at all. Hence, even to the best vaccinated, the additional security of re-vaccination at puberty is important, as giving all but complete safety from subsequent smallpox even of the mildest sort. But to all whose vaccination is other than the best (and it is certain that a considerable number of the present vaccinated adolescents and adults are in this position) re-vaccination is not merely important, but highly necessary. In every aspect of the case it would indeed greatly conduce to the security of the public against future smallpox epidemics if some means could be taken for giving effect to a rule which I ventured to lay down some years ago, and of the practical importance of which each year's experience has more and more convinced me, that "the re-vaccination of persons as they reach about fifteen years of age should be as systematically done as is the vaccination of young infants."

EDWARD C. SEATON.

December 31, 1874.

L O N D O N :

Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.

For Her Majesty's Stationery Office.

[7098.—500.—9/75.]